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CONTENTS.

PIECE WORK.

WITH PARTICULAR REFERENCE TO THE CAR DEPARTMENT.

CONDITIONS TO BE UNDERSTOOD BY MANAGEMENT AND MEN.

BY LE GRAND PARISH.*

Schedule making, or making of piece prices, should be approached with great care. Schedules should not be made by other than experienced men. Before a piece price can be properly made it is necessary to know whether the output under day work is up to the proper standard. It is necessary to look into conditions and location of machines, speeds, feeds and cuts, condition and speeds of engines and pulleys, unnecessary operations, patterns and conditions in general. After all these conditions have been carefully studied and necessary changes made, we are confronted with the usual question of whether the prices should be set by the foreman of each department or by an expert price maker. As we are treating with the car department problem, it may be well to refer to the usual manner of making prices, generally known as the timing system. The time of the workman is taken on each job and the time taken as a basis in fixing the price. This is a very uncertain method. Some of the more advanced shops use specially trained mechanics for this purpose and "try out" each job before fixing a price. The method of keying out the work by the number of bolts, nuts, lag screws, nails, screws, holes bored, etc., is no doubt the best for pricing car work, if the prices set on these elements are correct. This system should only be used by one thoroughly familiar with car construction.

It is sometimes necessary to guarantee the day rate to men starting piece work; this guarantee, if made, should be based on the earnings per month. It is not possible to make the guarantee on each piece work job on account of the tendency of some men to work hard on an easy job, or during good weather, and doing directly opposite on a job which looks hard or when the weather is bad. This would lead to great trouble and the necessary discharge of men who would act fairly if the guarantee was not given. The guarantee should not be given in any way if it can be avoided.

There are times when it pays both the men and the company to arrange the schedule so that a premium is paid to save material which otherwise would be destroyed.

In steel car work the prices may be based on the number and size of rivets in each part repaired, two-fifths of the price being given for cutting up and three-fifths for bolting up and riveting. This will enable the regular force to work on assembling and an extra force to work on cutting up when necessary. Piece work forces are not as flexible as day work forces, and we must provide as much as possible for such conditions. All operations in general which do not require skill should be started by unskilled labor. The unskilled labor will soon become skilled on the common operations and be able to greatly increase earnings above the day rate.

A system of cost sheets should be kept in order that the manager may know at once the reason for any decrease or increase in cost of work. This is a matter for an expert to look after, as it requires one of special training to do it right. Piece work statements should be made at the end of each month showing the amount earned per hour on piece work and the percentage of increase or decrease as compared to day work. A record should also be kept of the work completed by each gang of workmen in order that any decided increase or decrease may be discovered at once and the cause given careful study.

There are several systems of piece work: those in common use are the straight piece work, premium plan and differential system. The first, or straight, piece work system is the one in common use in car repairs. The other systems may be applied to the machine shop, wood mill, blacksmith shop, etc., but cannot be successfully applied to car repair work. Consideration should also be given to the fact that a certain percentage of old employes must be employed on day work for various reasons. Their number is never great, and they should be assigned to work which does not come in contact with piece work. A statement should be made each month showing the percentage of men working piece work and day rate in each department.

One of the most important points which must never be lost sight of is fixing the price on the item of work which is performed the greatest number of times. A mistake may be made in fixing the price on an item which is only performed once a month and not do much harm, but if, on the other hand, it is performed several hundred times per month the mistake would be serious. The adjustment of such mistakes is one of the most difficult things in connection with the management of piece work. This, of course, can be avoided if the schedule is properly made.

One of the common mistakes, and a very dangerous one, is to adopt a schedule used by some other road. Schedules of other roads are dangerous, as they cannot describe the conditions under which they are applied. Schedules should describe fully whether the material is to be delivered to the workmen or not; full explanation of the work should be given to avoid misunderstanding.

A correct history of all the prices should be kept showing when they were established, whether made by the foreman or piece work expert; also all changes in prices and the cause and date.

If prices or earnings at one shop on the system are compared with those of another, the following should be carefully considered and investigated:

Nationality of workman.

Average length of service.

* Master Car Builder, Lake Shore & Michigan Southern Railway, Englewood, Illinois.

Percentage of property owners.
Organization of shop.
Organization of storekeeping department.
Condition and location of material.
Percentage of heavy and light repairs.
Location of shops.
Length of time shops have been working piece work.

The first law of piece work is honesty, and departure from this law should meet with instant dismissal from the service. This applies to foremen as well as workmen.

Unnecessary haste is the cause of more mistakes when piece work is first started than all else combined. The management and workmen must gradually adjust themselves to the changed conditions, and great care must be exercised to avoid friction. If there is a mutual forbearance everything will soon move smoothly; mistakes will be made, but if a spirit of fairness prevails piece work will soon get down to a bearing and all will participate in the benefits. That it is of mutual benefit is conceded by those who are familiar with its workings.

The most important matter to watch closely is the instruction of piece work inspectors and foremen in the piece work schedules. They should not be allowed to give an interpretation of the schedule to the men until they can successfully pass an examination. All piece work inspectors should be instructed under the supervision of a competent instructor; this instructor to teach all inspectors on one railroad. This will insure a uniform understanding of the schedules and avoid an endless amount of trouble in the future. Great care and patience in the beginning are necessary to bring good results.

The foreman should receive careful attention when piece work is first started, as his relation to the men undergoes some radical changes. The workmen immediately find themselves in closer relation to the foreman; the elements "push" and "hustle" are largely transferred to them, and in view of this fact the foreman is liable to show some irritation when the workmen insist on prompt assignment to cars and immediate delivery of material, therefore, the foreman should be made familiar with these changes in conditions to avoid unnecessary friction.

When piece work is first started the foreman will be greatly surprised at the amount of material rejected by the workmen on account of improper workmanship in the wood mill, blacksmith shop and machine shop. Attention should be given to see that bolts, nuts, tenons, mortises and a large variety of items are of the right dimensions and fit properly. These are matters for the foreman to check up at frequent intervals. It is absolutely necessary to have a proper system of taking away refuse from repair sheds. The old material must be removed promptly in order to give the workman room to perform his work properly. The labor gang should be thoroughly organized and certain territory assigned to each man or each group of men and their efficiency judged by their ability to keep their respective stations clean. A dirty repair yard indicates poor management.

The selection of piece work inspectors and foremen should be made in a careful manner, as upon such selection depends the success of the system. The inspector should be absolutely honest; have a good education; write a plain hand, and, above all, be of proper mental balance; meet anger or misunderstanding with cool judgment and good nature; never give an answer to the workmen without first giving the question careful consideration. All of the above applies with equal force to the selection of a foreman. An absolutely correct knowledge of the schedule should be required of the piece work inspector and foreman before a piece work system can be called successful.

It is the first duty of the foreman to watch the work carefully to see that it is properly done; secondly, to see that the skill of the best workmen is explained to those who are not equally skillful, in which way the men are brought up to a higher standard and greater earning capacity. It is a fact that the man who makes the largest earnings, based on good work, is the most valuable man to the management. This is true because the earnings of a railroad depend upon the necessary equipment to handle traffic, therefore, every hour gained by the workmen in the time of repairing the car brings him increased earnings, and every hour so gained adds to the earning capacity of the car.

Voluntary service is without doubt the most valuable element in all organizations, therefore this should be kept in mind at all times in connection with the piece work question. Men as a rule are fair, and the truth must be made clear to them in order that they may understand that the man who earns a high rate for himself earns an equally high rate for the company.

In order that there may be no excuse for decreased earnings, the men should be advised as soon as possible after a car is completed the amount earned per hour.

All cars should be taken in regular order on tracks. A foreman should not be allowed to place men on a car out of their regular order, without authority given by the general foreman, the general foreman to make a report of all such transactions to the master car builder, master mechanic, or his direct superior, except as may be hereafter provided.

Forceful action should be taken to prevent the above mentioned practice, or one gang of men may do an injustice to the next gang following them. This practice is common with day workers and will be continued by men on piece work if it is not closely watched.

The success of the system depends largely on the storekeeper, as the material question is the most important of all. Without an efficient storekeeping department and thorough co-operation of the storekeeper and foreman, a permanent success is impossible. Material must be in stock all of the time, not part of the time. If it should happen that certain materials are not in stock when required by the workmen, the responsibility for such a serious condition should be placed where it belongs, and the management should take necessary action to prevent such a condition thereafter. Extraordinary effort must be made to keep all material in stock at all times, otherwise piece work is an absolute failure.

Proper location of supply racks and methods of handling material from the storeroom, wood-mill, blacksmith shop and machine shop is a very important factor in the cost of piece work. An industrial track system is necessary in a large repair yard; properly designed ball bearing trucks may be used to an advantage in a small yard. Attention is called to the usual delapidated condition of trucks, wheelbarrows, planking, etc. These conditions usually increase the labor cost and should be looked after by a competent man. If the material racks are widely distributed, the workmen will help themselves to a great extent and the cost of distribution will be materially reduced.

The supply gang should be carefully organized; a competent man put in charge with the necessary authority to see that the men are prompt to anticipate the wants of the workmen and treat all with equal fairness. The general foreman should take particular care to insure prompt and courteous treatment of the supply men by the foremen of the various shops. The earnings of the men depend largely on the efficiency of the supply organization and this fact must be strongly impressed on the minds of the general foreman, shop foreman and storekeepers. The foremen should make it a practice to repeatedly ask the men if they have the proper material with which to repair a car. It is the duty of the foreman and supply men to see that the workmen are promptly supplied with such material as should be delivered and also see that the material racks or local storeroom are properly supplied with such material as the men are required to procure.

Careful attention should be given to the selection and condition of all tools and appliances furnished the workmen. The piece workers will select the tools which will do the work the quickest and will discard all devices which are difficult to handle. It frequently occurs that a foreman or official in charge has some device of his own which he considers the best of its kind. He must be prepared to see it consigned to the scrap heap if the workman discovers some quicker method. The workmen will soon discover that it pays to keep their saws, chisels and other tools in good condition and the fore-

man should call attention to this when he finds workmen who do not understand its importance.

Experience has taught that one man will earn more when working alone than when two or more work together. The best plan in order to reduce the heavy labor to a minimum is to place two men in a gang. This is better for the men. It is possible in bad weather to work four men in a gang on cars under cover. The grouping of men should be thoroughly understood before starting piece work and will be appreciated by the workmen when they understand the conditions.

The number of men who can work on repair tracks to an advantage is determined by the output of the machinery and the amount of track room available. The repair track room is frequently used for storage of wheels and material of various kinds. This loss can be reduced by careful attention. There is a greater loss by poor management in switching tracks. This is not necessarily the fault of the switchman. It may be the fault of the foreman on account of not making up a switch list, showing the switchman just what is required. It is bad practice to have more cars on a repair track awaiting repairs than are necessary. If a foreman goes home at night and leaves a track tied up on account of work on one or two cars, he should be required to explain. There is a large amount of car service lost in such a case. A paint shop will greatly facilitate the movement of cars. Repair tracks which are not covered are frequently blocked with cars in bad weather, waiting for painting.

Time can also be saved if supply men take the material in need of repairs to the various departments promptly. Considerable time and expense may be saved if the material located in the material racks between repair tracks is charged out, the system requiring workmen to make out orders on storekeepers for material drawn for car repairs consumes too much time. The material is usually needed at once by the workman and these delays reduce his earnings with a consequent loss to the company. The workman should not be made to make out orders for such material as he is required to procure.

Under the piece work system the necessity for covering tracks becomes more apparent; storms seriously interfere with the earnings of the men and the output of cars at a time when they are badly needed. This is particularly true during heavy rain and snow storms and the expense of removing snow from repair tracks is heavy. All tracks upon which heavy repairs are made should be covered with sheds or shops. The loss of car service from such conditions is great and there is also a heavy loss in the various departments of the shop. The whole plant slows up and adjusts itself to the conditions on the repair tracks. Under a day work system it is customary to bunch men up on cars in the shop if one is available. This plan is not practicable on piece work. It also seriously interferes with switching. This is particularly noticeable when repair tracks can only be switched from one end.

Some additional suggestions are briefly stated as follows:

Workmen should be required to correct improper work at their own expense.

Shop rules should be strictly inforced under piece work systems. The tendency to lay off increases with increased earnings. Men who are continually absent without sufficient cause interfere with the system and should not be tolerated.

Piece workers should not be placed on day work unless absolutely necessary. It is better to make a price for the day work jobs.

Schedules should be located in convenient places where workmen can look up prices at their convenience.

Men working in gangs should be taught to separate as much as possible in order to avoid helping each other when not necessary.

If any misunderstanding arises, it should be settled as quickly as possible.

Cars should be properly spaced for convenience in handling material and repairs as far as economy will permit.

Foremen should be required to make all estimates of car repairs on a piece work basis. Piece work in all departments should be introduced slowly in order to avoid mistakes.

HIGHSPEED STEEL IN RAILROAD SHOPS.

Its Great Advantages and How to Obtain Them.

BY HENRY W. JACOBS.

As a result of extended observation and considerable experience in handling the new steels and applying progressive methods in connection with them, I would lay it down as a cardinal principle that before any attempt is made to put in so radical a factor of increased production as the new highspeed steel, the fullest attention should be given to the machine end of the plant, and to the methods in vogue at the place where these steels are to be introduced. No amount of steel, bought out of hand, is going to revolutionize the manner of doing the work; and mere purchase of expensive grades of steel will not

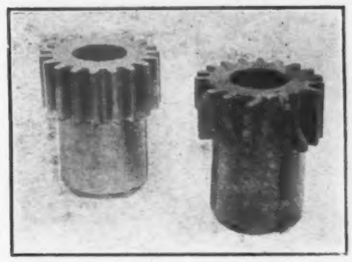


FIG. 1.—STEEL PINION TO REPLACE CAST-IRON ONE IN COACH WHEEL LATHE.

cheapen the cost of production. Even if the new tools are being introduced by men who understand them thoroughly and who exercise energy in applying them to practical work, the result will not always be up to expectations, and a host of unsuspected and discouraging evils will be brought in.

In the first place, the majority of machine tools in railroad shops to-day are not designed or built to stand the service that the highspeed steel would demand of them. To introduce these steels in the ordinary course of events will often prove disastrous to the machines (Fig. 1), if these are speeded up or

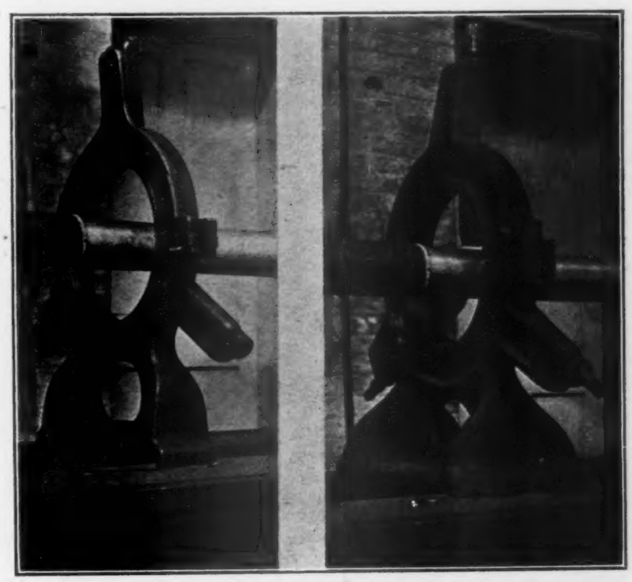


FIG. 2.—STEADY REST, REDESIGNED FOR HEAVY CUTTING SERVICE.

worked with heavy cuts, unless proper safeguards are taken. The depreciation rate becomes much greater under the new condition than under the old; but with proper management it will be found profitable to do this when the increased production capacity is realized.

The most difficult factor to deal with, however, when there is not the whetting of competition (as in the case of commercial shops) to force the management to be vigorous in prosecuting improved methods, is the attitude of the men, who have grown used to the old ways, and who view with hostility and

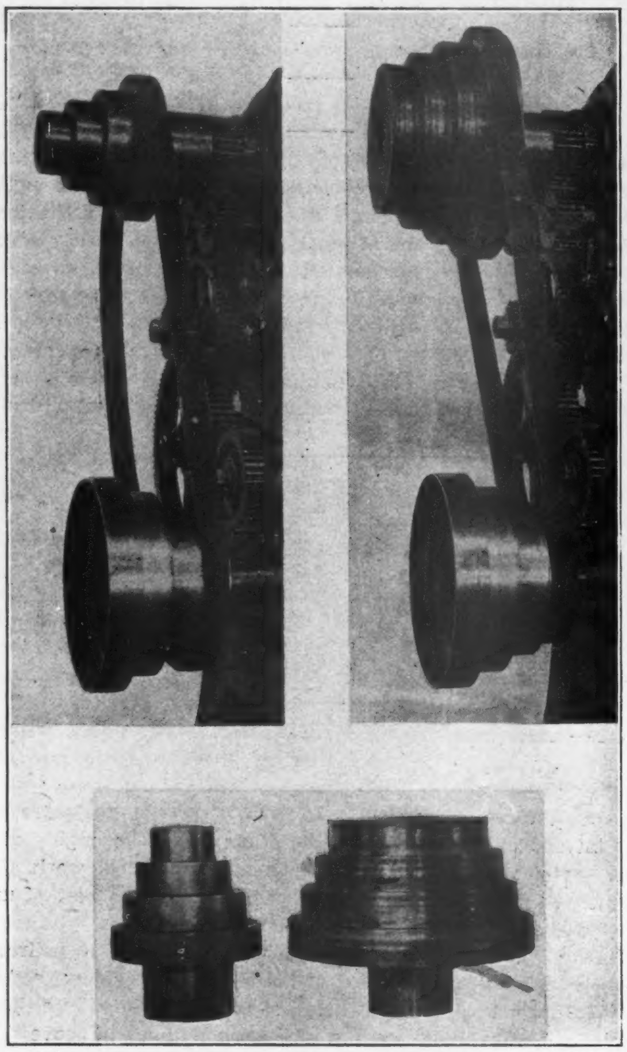


FIG. 3.—FEED CONE PULLEY FOR LATHE INCREASED TO ACCOMMODATE NEW FEEDS.

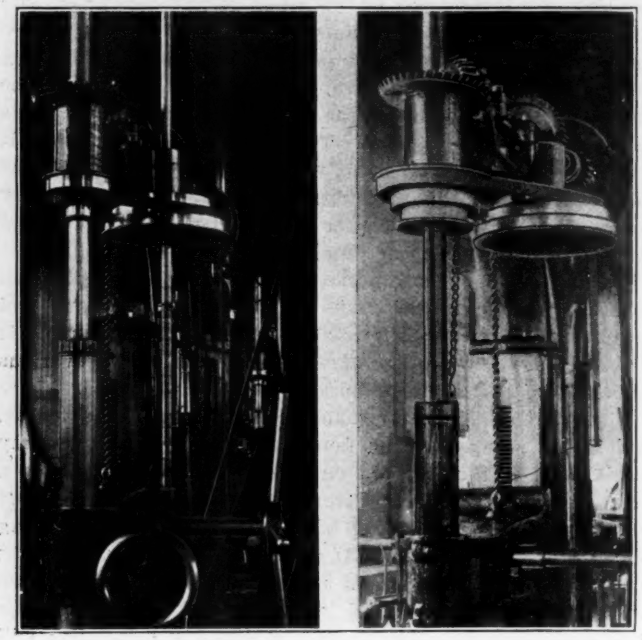


FIG. 3A.—FEED CONE PULLEY FOR DRILL PRESS, SHOWING INCREASE.

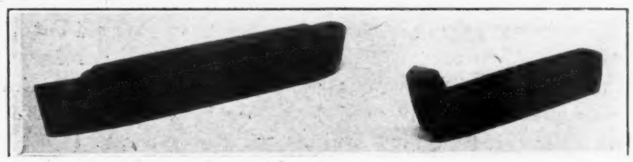


FIG. 4.—ROUGHING TOOLS. NEW ROUND NOSE, SUPPORTED CUTTING EDGE STYLE, AND OLD DIAMOND POINT, UNSUPPORTED STYLE.

FIG. 5.—SNAP RING MILLING MACHINE. WHAT A MACHINE FOREMAN WILL DO WHEN ENCOURAGED.

FIG. 6.—EXTENDED PISTON RODS.

suspicion any innovation of this character. Unless a Director of Methods or Demonstrator is employed, whose special duty it is not only to direct how the tools shall be made and used, but also to keep the men up to the new cuts and speeds, the great majority of the men will be most loath to maintain the increased pace that the new steel necessitates in order to be a paying proposition. To get around this difficulty the writer has found it an excellent plan: First, to examine the machines as to their capability of standing the increased service, to remedy what defects might be found (Fig. 2). Then immediately to increase the speeds, by changes in pulley sizes on both main and countershafts, so as to have the machines in general running at a rate of speed much above that used with the older tool steels.

These speed increases may vary from 30 per cent. to over 200 per cent. above the original speed. They are not attained by one jump, but by a succession of judicious increases, gradually getting the men used to the higher speed, to a busier hum of pulleys and machines, to a greater rapidity in turning out the work. By making these changes (Fig. 3 and Fig. 3a) and at the same time following up the matter of proper use of cutting tools, with proper feeds and cuts, the men are induced, almost unconsciously, to fall in line with the new methods.

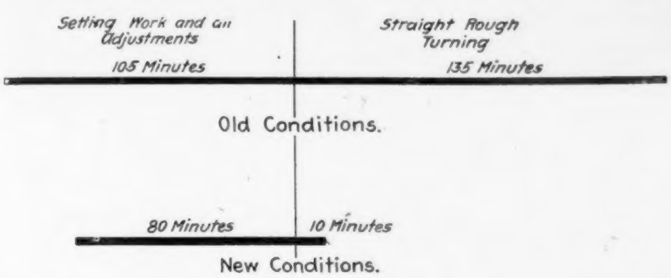


FIG. 7.

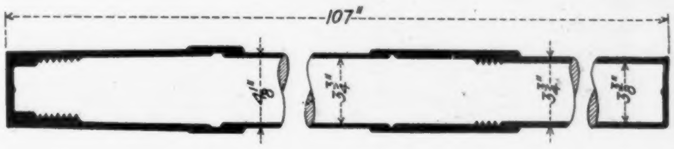


FIG. 9.—SECTION SHOWING METAL REMOVED (IN BLACK) FROM ROUGH FORGING.

One *very essential point*, which should not be overlooked, is that every tool of the older steels should be withdrawn from the shop entirely, and highspeed tools substituted, so as to prevent any tendency to cling to the old ways of doing things (Fig. 4).

Not only do the mechanics object to innovations, but the gang foremen, foremen, and general foremen even, do not accustom themselves readily to the new conditions. For it must be remembered that the foreman of a shop, more particularly of a railroad shop, has so many duties devolving upon him that he does not, as a rule, have sufficient time for looking after a new move of this kind. The introduction should, therefore, be in the hands of a man whose whole time can be devoted to the handling of the new tools. This man should be a thorough mechanic, well informed as to the care and working of these steels, and of sufficient inventive ability to devise quick methods and ways of economizing work. He should also possess the knack of being able to get along with the workman with a minimum amount of friction, for the attitude of hostility before mentioned is never so much in evidence as when the man who is responsible for these changes is actively engaged. And he should stimulate the foremen with whom he is working, to advance ideas, such as that shown in Fig. 5 (for which full credit is given when successful), even to a spirit of rivalry with himself in the introduction of time-savers.

Yet the individual capacity and tact of this demonstrator will not alone meet the problem. Unless full support is given by the superintendent of motive power himself, unless it be well understood that he intends making a success of the new methods, and it be shown from time to time, by personal talks with the more influential foremen, and in other ways, that these innovations are no mere vagaries of an unpractical man who is only "on trial," the progress of improvements will be hampered at every turn. Moreover, as the chief attention of the demonstrator will be required in the shop so as to keep the new methods moving, he should be afforded the use, when necessary, of draughtsman and stenographer, as it will not pay to have him spend his time over the drawing board, or in writing out, longhand, whatever communications he needs to make.

These are the main points to be considered in the introduction of the new alloy steel tools, or rather the obstacles to

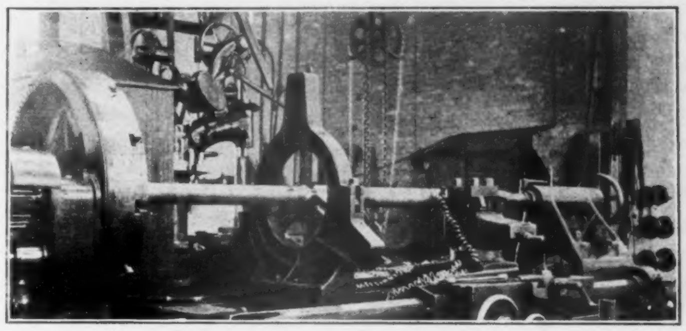


FIG. 8.—TURNING EXTENDED PISTON RODS.

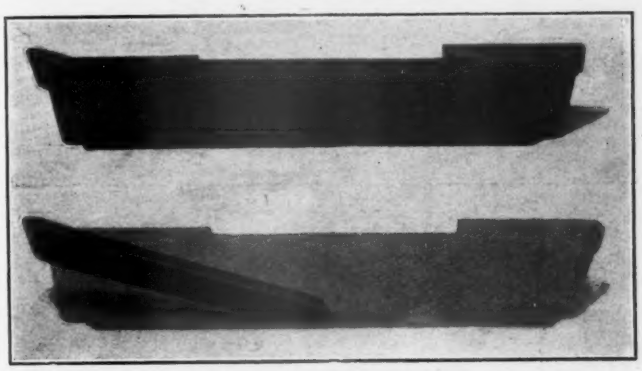


FIG. 10.—TOOL HOLDER FOR HIGH SPEED TOOL. LOWER VIEW SHOWS POSITION OF ROUGHING TOOL.

which chief attention must be given and which must be overcome before any permanently beneficial results can be obtained. As to the results themselves, no better evidence may be given of what can be accomplished than to cite examples of what has been done in a shop where these principles have been adhered to. When the new steel tools were first announced extensive tests were made in this shop of all brands that could be secured, and steps were taken to secure a man who could direct their introduction. While, of course, the superintendent of motive power could not devote time and attention to each little detail, yet he directs in a large and farsighted way the lines it would pay best to follow, and it must be acknowledged that without his interest no such degree of success could be attained. I need only add that the cases that follow are not special record ones (as was that of turning a pair of 68 in. driver tires in one hour and 31 minutes), but are typical of everyday performance. The same character of results has been attained in hundreds of other such jobs.

EXTENDED PISTON RODS.—These rods (Fig. 6) were rough forged in the blacksmith shop. The time for complete turning, threading, fitting, etc., under the old conditions, was 14 hours. When the new steels were put in, the man on this work was supplied with an outfit of tools and instructed to get the most he could out of them. The best time he made was 12 hours, but even this did not always keep up when the man was left to his own resources. This reduction in time was obtained by using a faster step on the cone pulley, and by increase in the depth of cut. However, as it was rather inconvenient to make the belt changes, the man preferred to run

at a slower rate. The matter was then taken hold of by the demonstrator and a number of changes were made. First, the work was divided between two lathes, one for rough turning and one for finishing. The lathe for rough turning was an old one, but was put in shape, fitted with steady rests (see Figs. 2 and 8), etc., and adapted for turning roughly to within 1-32 in. of finished size. The pulleys on main and countershafts were changed, making a speed increase of from 140 to 320 r. p. m. This maintained the higher turning speed even on the lower cone pulley step. A second-year apprentice was used on this part of the work, replacing the more conservative machinist, and he was induced to use the higher step at the cone pulley. The peripheral speed of the work was thereby changed from 20 ft. to 65 ft. per minute. On rough turning the depth of cut was doubled, thus finishing a rod with only one heavy roughing cut instead of two. The feed was increased from 1-16 in. to 5-32 in. The total time of rough turning under the new conditions was, therefore, $\frac{1}{3\frac{1}{4} \times 2 \times 2\frac{1}{2}}$ or about 1-16th of the former time. This is for *actual* rough cutting. The former time of complete rough-turning was two hours and fifteen minutes, to which must be added one hour and three-quarters for setting work, etc. Under the new conditions, although the actual rough cutting time was reduced to about *ten minutes*, the complete time of rough turning was one hour and a half, the additional hour and twenty minutes being the sum of all the times necessary to turn the rod end for end, apply and take down chucks and dogs, rough turning taper and collar, threading, grinding tools, etc. In other words, the *ratio* of cutting time to total time was greatly reduced. The black line diagram, Fig. 7, illustrates where the saving was effected.

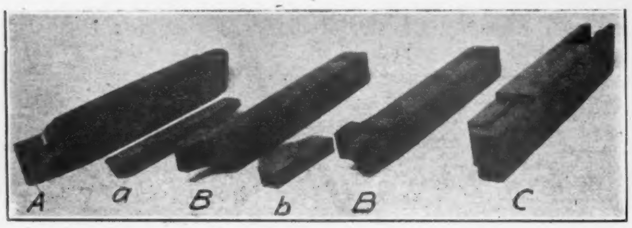


FIG. 11.—TOOL HOLDER FOR USE ON WHEEL LATHES AND SOLID TOOLS DISPLACED BY SAME.

"*a*" AND "A"—TOOL HOLDER AND BAR SIZES OF ROUGHING TOOL.
"*b*" AND "B"—TOOL HOLDER AND BAR SIZES OF FLANGING TOOLS.
"C"—TOOL HOLDER PROPER.

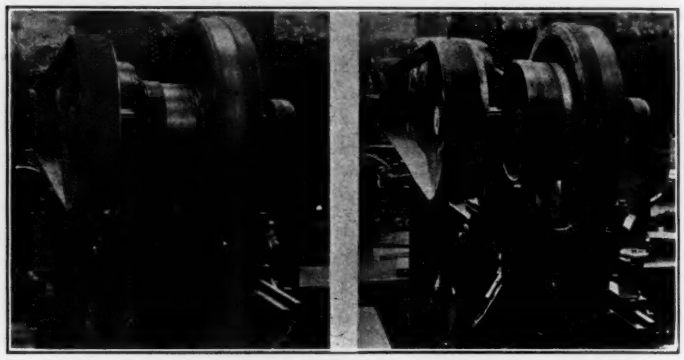


FIG. 12.—PULLEY INCREASE ON PLANER.

FIG. 13.—POWER INCREASE ON PLANER. 10 H.P. TO 20 H.P.

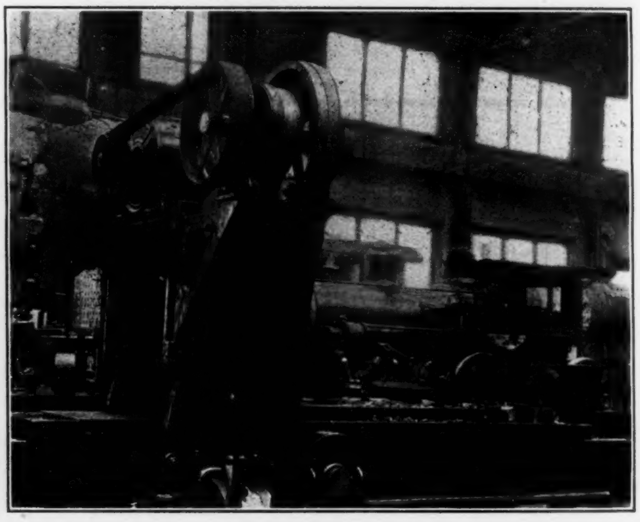


FIG. 14.—PLANER EQUIPPED FOR HIGH SPEED WORK.

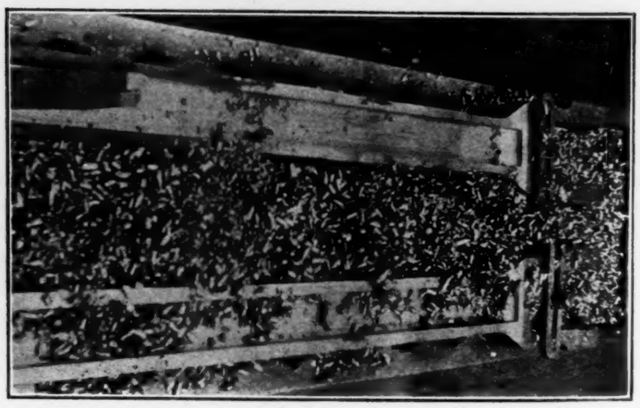


FIG. 15.—BLUE CHIPS FROM PLANER SHOWN IN FIG. 14.

In the finishing process similar methods were employed, with similarly gratifying results, although here the principal time savings were by methods and not by high speed steel, so that, all in all, the time reduction of six to seven hours on this one job (see Fig. 9) was due as much to intelligent modification of the conditions under which the new steels were to act as to the steels themselves.

COACH WHEEL TIRES.—Another example is that of the time on one pair of steel tired coach wheels, where a reduction was made from five hours to one hour. As in the previous case, in-

crease in pulleys, thus permanently increasing wheel lathe speed, and other changes, such as special designs of tool holders (see Figs. 10 and 11), substitution of forged steel pinions for cast iron (see Fig. 1), so the machine could stand the increased strain were all instrumental in accomplishing the desired results.

PLANERS.—Speed increases were made in the principal planers up to a cut of over 50 ft. per minute, or the limit under this heavy work of the tools. One result of this change is a close approach of the reverse speed to that of the cut, as nearly the limit of the machine's capacity to overcome the inertia of the table is reached under the changed conditions. Figs. 12 to 15 illustrate improvements in planer practice.

If space permitted numerous other instances could be cited, all taken from actual shop practice, such as turning eccentrics, cylinder bushings, car axles, planing shoes and wedges, etc. The time on all these was reduced from one-half to one-eighth of former time. The average increase, based on actual output, and the difference in weight of metal removed was:

Cast iron	120 per cent.
Steel	150 per cent.
Good, clean wrought iron	175 per cent.

CONCLUSIONS.

In conclusion I can but repeat that the buying of high-speed steel is of little use unless progressive methods of application in actual work are employed to effect real reduction in cost, which is the final and only test in the question. In order to introduce these methods it is always better policy to bring into each shop a man who has not been brought up in the traditions of the place, and have him make the changes, the possibility of which would not be seen as rapidly by one too used to the older conditions. A local demonstrator should report direct to the superintendent of shops, or where there is no such position, to the division master mechanic, so that he will have sufficient authority behind him to carry out his plans, and so that general and important interests may not be sacrificed to local and individual preferences. If there were a general demonstrator for an entire railroad system, the local demonstrator should report to him, and he in turn direct to the highest authority in control of the different shops, the superintendent of motive power. Of course, upon the latter person the ultimate success or failure of an enterprise of this kind must rest. So far as I know, Mr. W. R. McKeen, Jr., of the Union Pacific, has been the only, or at least the first, superintendent of motive power who has had the temerity to create a position of this kind, and who has used the force to drive his purpose home. That he has been amply justified is admitted by all who have had the opportunity to see the results accomplished in the shops on his system, not alone in the new Omaha shops, but also in the redistribution of work among all the shops, made possible by the increased capacity and concentration of manufacture in the main shops, and in the economies effected by restricting the smaller and less well equipped points to repairs requiring light machine work only.

ALTERNATING CURRENT MOTOR FOR ELECTRIC CARS.

An important development in electric car motors which promises to materially decrease the cost of the installation and operation of interurban electric lines, and that will probably be a large factor in solving the problem of applying electricity to certain parts of steam railroads, has just been made by the General Electric Company at Schenectady. On the Ballston extension of the Schenectady Railroad Company is a car in regular service operated by single phase alternating current motors. Three-phase alternating current motors have been used for this purpose in Europe, but on account of the limitations of the multipolar induction motor have never been adopted here, and this is the first instance in this country of a car being operated in regular service by alternating current motors.

Of still greater importance, however, is the fact that the motor, which is of the "compensated" type, so called because of the character of the field winding, which fully neutralizes or compensates for the armature reaction, can be operated equally well with either direct or alternating current. On the Schenectady line the car is operated through the city for 3.9 miles on a 600-volt direct current trolley and through the country for 11.6 miles on a 2,000-volt alternating current trolley. Change from one system to the other is made by shifting the trolley, which can be done while the car is running at a considerable speed, and the car starts, runs or stops equally well with either system.

In the cities it is necessary to use a comparatively low voltage direct current because of the danger from falling wires, etc., and for a long system the cost of the copper for transmitting this low voltage current becomes a serious one. With this new motor a high voltage alternating current can be used in the suburban and country districts and the cost of copper wire can thus be greatly reduced. A transformer carried under the car reduces this high voltage current to the potential required by the motors. The first cost of the power houses and the operation expense will also be reduced, for at present the larger installations are usually equipped with alternating current generators which require rotary converters or other commutating devices for changing the alternating current to a suitable direct current.

FAST RUN ON THE READING.

The Reading's 60-minute Atlantic City flyer, scheduled to leave Chestnut street, Philadelphia, at 3:40 p. m., and to arrive at Atlantic City at 4:40 p. m., last Thursday, July 21st, not only broke its own record, but established a new high-speed record for scheduled passenger trains. The distance between Kaighn's Point, Camden and Atlantic City, 55.5 miles, was made in 43 minutes, the speed for the entire distance being equivalent to 77.4 miles per hour.

To accomplish this, very high speeds were made over portions of the run but as the train sheet record, presumably taken from different timepieces, is the only one available, no attempt will be made to give maximum speeds.

Train No. 25 was the first of the 60-minute flyers between Philadelphia and Atlantic City, and made its initial run on July 2, 1897. This was an innovation in fast scheduled running to Atlantic City, and the remarkable record attained by the train in July and August of that year, the two months it was in service, attracted attention not only at home but abroad. The train during its first season distinguished itself for going into Atlantic City from 2 to 4 minutes ahead of schedule, and not once during the season did it arrive behind time. This year's best record was on July 14th, when the run of 55½ miles was made in 46½ minutes, an average of 71.6 miles per hour.

On August 5, 1898, the train made its record, which remained unbroken until July 21 of this year. On that day the train left Kaighn's Point at 3:51 p. m., one minute late, and pulled into Atlantic City at 4:36¼, 3¾ minutes ahead of schedule, having made the run in 44¾ minutes, the speed for the entire distance having been equal to 74.4 miles an hour.

An account of a regular run of this train made in August 1898, with mile post timing taken by the editor of this journal, was printed in the October number of 1898, page 341.

TWO HUNDRED AND FORTY-FIVE MILES WITHOUT A STOP.—Two regular daily runs of this distance without an intermediate stop have been inaugurated by the Great Western Railway of England, between London and Plymouth, the time card speed being 55.6 m.p.h. According to *The Engineer*, the trains weigh about 160 tons behind the tender. In a preliminary run such a train was forced into a speed of 60 m.p.h. at the end of the third mile from the start.

THE SCHENECTADY SUPER-HEATER LOCOMOTIVE.

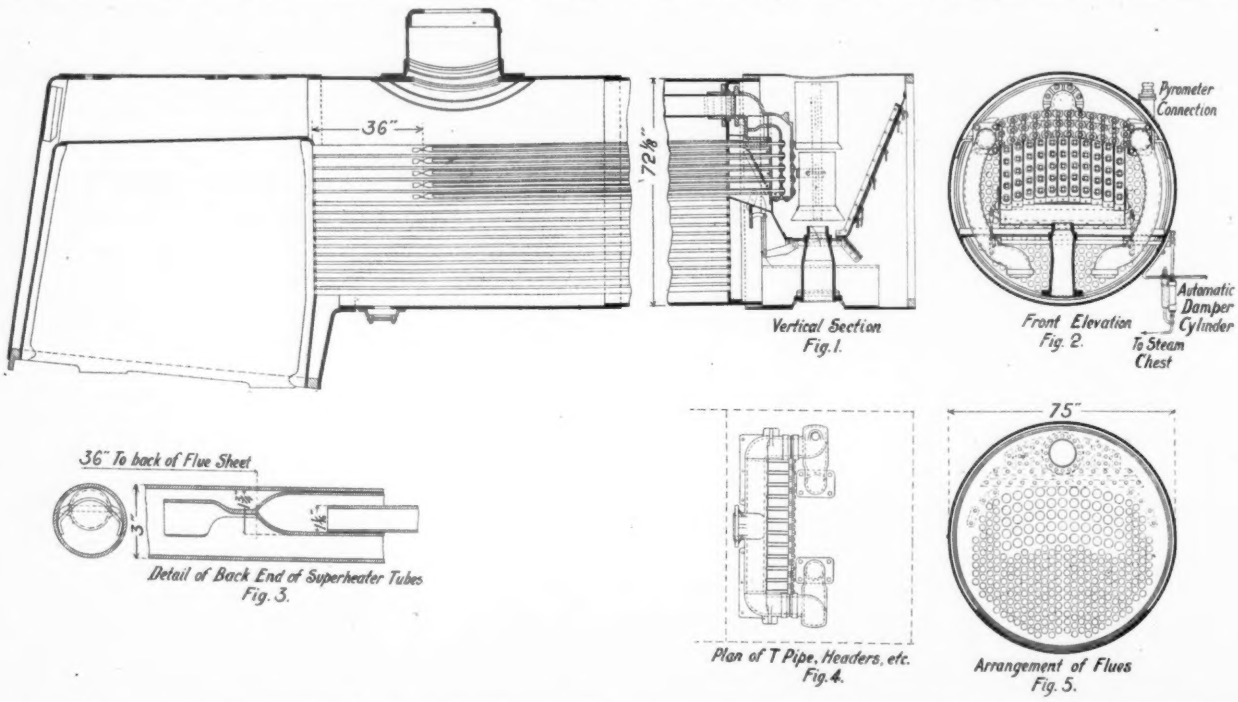
The American Locomotive Company has brought out a new locomotive super-heater, designed by Mr. F. J. Cole, mechanical engineer of the company, and which is to be known as the "Schenectady" super-heater; it has been applied to New York Central Atlantic type (4-4-2) passenger engine 2915, now in regular service on the Mohawk Division between Albany and Syracuse, N. Y., and similar to the design illustrated in this journal in February, 1901.

The objectionable features of previous locomotive super-heaters, both abroad and in this country, have been, first, the use of bent tubes; and, second, the necessity of dismantling the whole super-heater in order to secure access to a single leaky boiler tube. The accompanying illustrations show that these difficulties have been eliminated, the construction and operation of the new super-heater being as follows:

The first new feature of construction is in the T-pipe, the regular conventional T-pipe being replaced by one of special design, shown in Figs. 1, 2 and 4; it will be seen that this T-pipe is subdivided into two compartments by a horizontal partition, and that it extends nearly across the smokebox; steam entering the T-pipe from the dry pipe is admitted to the upper compartment only. To the front side of the T-pipe are attached eleven header castings, the joints being made with copper wire gaskets, as in steam chest practice. Each header casting is also subdivided into two compartments, but in this case by a vertical partition; five pipes or flues of 1 1-16-in. outside diameter are inserted through holes (subsequently closed by plugs) in the front wall of each header casting, these 1 1-16-in. tubes having first been expanded into special plugs, are firmly screwed into the vertical partition wall. These 1 1-16-in. tubes are enclosed by 1¾-in. tubes, which are expanded into the rear wall of the header casting in the usual way. Each nest of two tubes (one 1 1-16-in. and one 1¾-in.) is encased by a regular 3-in. boiler tube, which is expanded into the front and back tube sheets as usual. The back end of each 1 1-16-in. tube is left open; the back end of each 1¾-in. tube is closed; the back ends of the two tubes being located at a point about 36 ins. forward from the back flue sheet. The detail arrangement and grouping of the three flues are shown by Fig. 3. The back end of the 1¾-in. tube is closed by welding, and the tail is so formed as to support this tube in the upper part of the 3-in. tube, thus leaving a clear space below. Fig. 1 indicates that the 1 1-16-in. tubes are concentric with the 1¾-in. tubes at their back ends, but the fact is the 1 1-16-in. tube is allowed to drop and rest on the bottom of the 1¾-in. tube, as shown by Fig. 3.

Steam from the dry pipe enters the upper compartment of the T-pipe and thence enters the forward compartments of each of the 11 header castings, and then passes back through each of the 1 1-16-in. tubes, thence forward through the annular spaces between the 1 1-16-in. tubes and the 1¾-in. tubes to the rear compartments of each of the 11 header castings, thence into the lower compartment of the T-pipe, thence by the right and left steam pipes to the cylinders. In passing forward through the 1¾-in. tubes the steam is superheated by the smokebox gases and products of combustion passing through the 3-in. tubes. In this particular design 55 3-in. tubes are inserted in the upper part of the flue sheets, thus displacing as many of the regular smaller tubes as would occupy the same space. The arrangement of flues is clearly shown by Fig. 5.

In applying the super-heater to a locomotive it is necessary to provide some means by which the super-heater tubes shall be protected from excessive heat when steam is not being passed through them. In this design this is accomplished by an automatic damper, as shown in Figs. 1 and 2. That portion of the smokebox below the T-pipe and back of the header casting is completely enclosed by metal plates; the lower part of this enclosed box is provided with a damper which is automatic in its action. Whenever the throttle is opened and steam is admitted to the steam chests the piston of the automatic damper cylinder, shown in Fig. 2, is forced upwards and the damper is held open, but when the throttle is closed the vertical spring immediately back of the automatic damper cylinder (and concealed by it in Fig. 2) brings the damper to its closed position, so that heat is not drawn through the 3-in. tubes when the engine is not using steam. In this way the super-heater tubes are effectively prevented from being burned. In introducing the group of 3-in. tubes and applying the super-heater, there is a slight loss of heating surface, but it is more than offset, as regards economical results, by the super-heating process. The heating surfaces of the regular New York Central Atlantic engine and the sister engine, which is fitted with the super-heater, are shown by the following table:



APPLICATION OF "SCHENECTADY" SUPER-HEATER TO NEW YORK CENTRAL, ATLANTIC TYPE, PASSENGER LOCOMOTIVE.

HEATING SURFACE (sq. ft.).

	Regular Engine.	Superheater Engine.	Loss per cent.
Fire box	175.0	175.0	0.0
Fire tubes	3248.1	2837.0	12.6
Arch pipes	23.0	23.0	0.0
Totals	3446.1	3035.0	11.9

It is noticed that the application of the super-heater reduces the heating surface of the fire tubes by 12.6 per cent., and reduces the total heating surface by 11.9 per cent. The actual

super-heating surface is 301 sq. ft., which is 10.6 per cent. of the fire tube heating surface, and 9.9 per cent. of the total heating surface of the super-heater engine.

A pyrometer is inserted in the left steam pipe, as shown in Fig. 2; readings from this pyrometer since the engine has been in service show that the average temperature is about 517 deg. F.; the boiler pressure being 200 lbs. per sq. in., and the corresponding temperature being 387 deg. F., a super-heating of 130 deg. is accomplished.

As indicating the possible economies which may result from the use of super-heated steam in locomotives, it may be said that service tests on the Canadian Pacific with a super-heater locomotive showed savings (on the ton-mile basis) of 33 per cent. in fuel consumption, as compared with a similar engine, and 16 per cent., as compared with a similar compound engine, when the performance was reduced to the same unit of comparison.

The piston rod metallic packings are made of a special mixture (which, in this particular case, is a mixture melting at about 1,200 deg. F.), to guarantee that they will not be unfavorably affected by the excess heat in the cylinder. When super-heated steam is used no chances can be taken as regards lubrication of the cylinders, and, therefore, forced feed is resorted to instead of the usual gravity feed. Although the maximum steam temperature is about 517 deg., as stated, yet the constant temperature of the cylinder walls is probably something above the mean of 517 deg. and the average temperature (perhaps 230 deg.) of the exhaust; it is therefore probable that the constant temperature of the cylinder walls, when steam is being used, is in the neighborhood of 385 deg., which, however, is considerably higher than the corresponding temperature would be in the case of an engine not equipped with a super-heater.

The particular forced feed lubricator which is used in this case is of German make, and embodies four reservoirs, which are filled with oil before the beginning of the run, the oil being forced out of these reservoirs through connecting pipes to the cylinder by plungers which receive a gradual but constant downward impulse by a screw motion, which is actuated by a system of levers connected with a return crank on one of the rear driving wheels; in this case two oil pipes are led forward from the lubricator to either side of the engine; one of each pair of oil pipes enters the live steam passage through the cylinder saddle, and the other is led directly into the cylinder at the middle of the stroke.

Casual consideration of this design might lead to the prediction that the upper or 3-in. tubes would be likely to choke up in service; but it should be remembered that the annular space in the lower part of these tubes is quite free and unobstructed, and can easily be reached and scoured by a steam jet from the firebox end. It should also be borne in mind that the upper flues in any locomotive are not nearly as likely to choke up as the lower flues.

NEW LOCOMOTIVE AND CAR SHOPS.

McKEES ROCKS, PA.—PITTSBURGH & LAKE ERIE RAILROAD.

VIII.

MACHINE TOOL EQUIPMENT AND CRANES.

The arrangement of the machine tools, lavatories, foremen's offices, etc., in the machine and boiler shops is shown on the accompanying diagrams. The end of the machine shop nearest the wheel yard is entirely devoted to machines for handling the wheel and axle work for both locomotives and cars. A trolley fitted with an air hoist extends from the wheel presses to the axle lathes. About the entrance nearest the blacksmith shop are grouped several drill presses, lathes, etc., for handling the forgings. The machine tools and air press for handling driving and truck boxes and brasses are arranged so that this work can be passed from one to the other in regular order. The tools for machining heavy castings are placed near the entrances from the casting house and storehouse. A large amount of space in the middle bay of the machine shop is available for additional machines as they may be required.

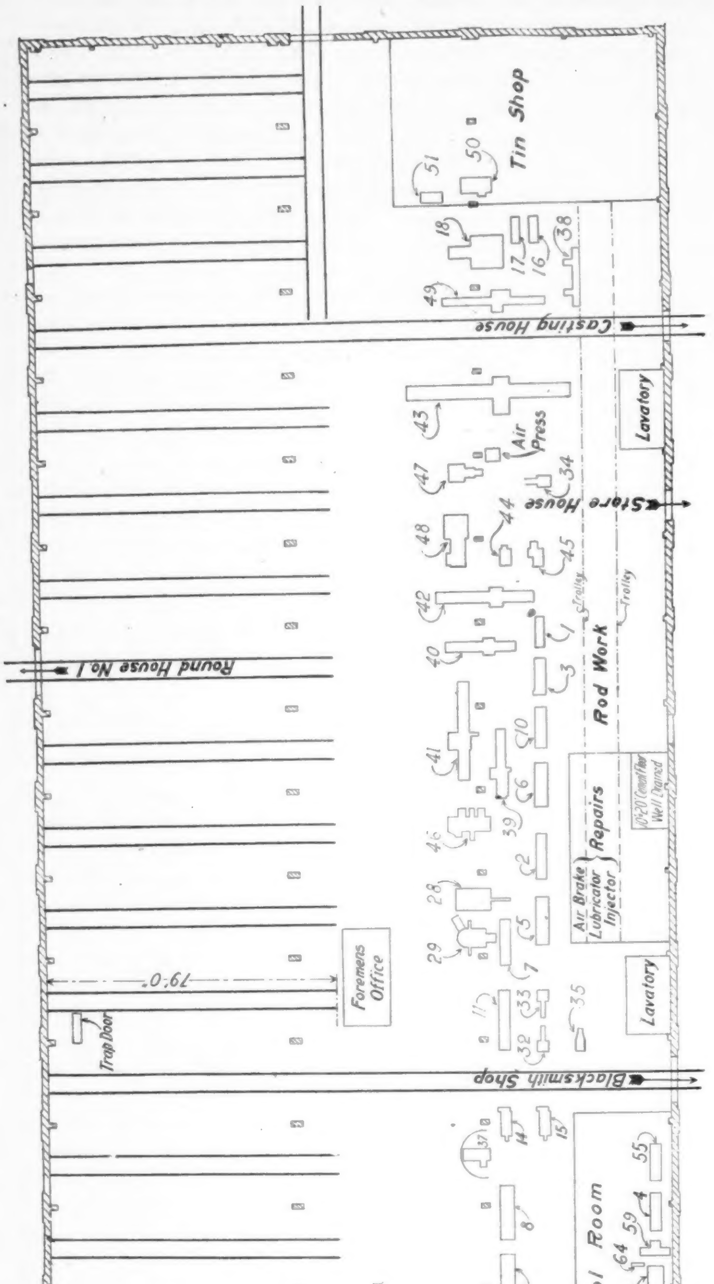
CROCKER-WHEELER CO. M.F. 21 CONTROLLER USED IN MCKEES ROCKS SHOPS.

Reference to the machine tool list will show that a large number of them were taken from the old shop and equipped with individual motors, and this may cause some comment, as we hear much these days about scapping old machines to make way for those designed especially for the use of the high-speed tool steels. When the question of what machines should be transferred from the old shops came up, the new tool steels were in an experimental stage and very little was known of them. The management, however, realized that there would probably be a considerable development along this line and decided to retain only the best of the old machines, some of which were comparatively new, to uniformly increase the spindle speeds with a view to using a better tool steel, and to replace cast iron gears by steel ones where it appeared necessary. It is interesting to note that although new tool steels and commercial methods are being introduced into the shop as rapidly as possible, yet the old machines with the individual motor drives are giving good satisfaction in practically all cases.

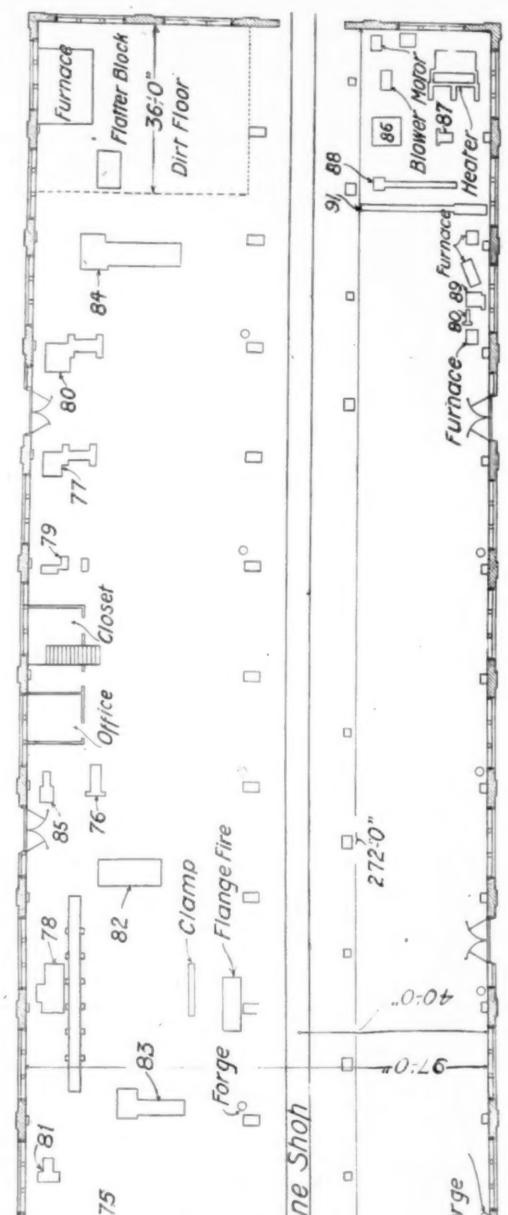
The reason for this is that most of the forgings and castings are made so that they can be finished by taking a comparatively small roughing cut and the old machines, even though cutting at a considerably higher speed than before, can easily handle this class of work. The application of motors to the old tools has been very completely described in the series of articles on "The Application of Individual Motor Drives to Old Machine Tools" which have appeared in this paper.

There is a group drive in the machine shop and one in the boiler shop, which contain the lighter tools and those requiring constant speed that could be gathered together in one place without interfering with the movement of the work. The group drives are in both cases arranged along the side walls and the shafting is hung below the crane runways, so as not to interfere with the cranes.

Briefly, the reasons for individually driving such a large percentage of the machines are as follows: A closer speed regulation is afforded; speeds can easily be changed; allows



MACHINE SHOP LAYOUT.—MCKEES ROCKS SHOPS.—PITTSBURGH & LAKE ERIE RAILROAD.



BOILER SHOP LAYOUT.—MCKEES ROCKS SHOPS.—PITTSBURGH & LAKE ERIE RAILROAD.

head room for cranes; increases light and cleanliness; machines can be placed to best possible advantage and can easily be rearranged; a few machines can run overtime without operating a shop full of shafting; a tool is using no power when it is not running; construction of the building is simplified.

In general the old machines were arranged for a maximum cutting speed of 60 ft. per minute and the new ones for 70 ft. per minute. On both the old and new tools, as far as possible, all changes in driving gearing are made by means of substantial jaw clutches or an approved form of friction clutch operated by handles placed convenient to the operator's hand. The motor controller hand wheel is also placed in a convenient position. The first reduction from the motor to the tool is made either by a silent chain or by gearing.

The Crocker-Wheeler Company four-wire multiple voltage system, described in connection with the Collinwood shops on pages 23 and 24 of the January, 1903, issue is used with the variable-speed machine tool motors. At McKees Rocks, however, the 12-point controller, in which the intermediate speeds between the six voltages are obtained by the use of resistance placed in series with the armature, is used only with some of

the boiler shop tools which do not require numerous or accurate speed changes. For the other machine tools, which are driven by variable-speed motors, a new controller, known as the M.F. 21 is used, in which the intermediate speeds between the six voltages are obtained by inserting resistance in the field circuit. Diagrams showing the relation between the speed and power of a motor using the M.F. 21 or field weakening controller and the M.A. 12 or armature resistance controller are shown on page 165 of the May, 1903, issue in connection with one of the articles on the application of motors to the old machine tools at McKees Rocks.

On the M.F. 21 controller points 1, 2 and 3 are used for starting only. Between points 4 and 21 inclusive, there is a speed range of 4 to 1, the average speed increment being 9 per cent. Experience has shown that when no resistance is used in series with the armature, there is a heavy rush of current in

LIST OF TOOLS—LOCOMOTIVE DEPARTMENT.

McKEE'S ROCKS SHOPS—PITTSBURGH & LAKE ERIE RAILROAD.

MACHINE SHOP.

INDIVIDUAL MOTOR-DRIVEN.

	No.	Tool.	Maker.	Motor H. P.
	1	18-in. x 8-ft. lathe	Flather & Co.	5
*	2	18-in x 10-ft. lathe	Putnam Machine Co.	7½
	3	20-in x 8-ft. lathe	F. E. Reed Co.	5
	4	20-in. x 8-ft. lathe	F. E. Reed Co.	5
*	5	20-in. x 11-ft. lathe	Putnam Machine Co.	7½
*	6	20-in. x 11-ft. lathe	Putnam Machine Co.	7½
*	7	20-in. x 11-ft. lathe	Putnam Machine Co.	7½
	8	24-in. x 12-ft. lathe	American Tool Works Co.	7½
	9	24-in. x 12-ft. lathe	F. E. Reed Co.	7½
	10	25-in. x 6-ft. lathe	Putnam Machine Co.	7½
*	11	30-in. x 15-ft. lathe	Putnam Machine Co.	10
*	12	36-in. x 24-ft. lathe	Putnam Machine Co.	10
	13	42-in. x 8-ft. lathe	Niles Tool Works Co.	15
	14	Turret lathe	Jones & Lamson Machine Co.	5
	15	Turret lathe	Jones & Lamson Machine Co.	5
	16	Turret lathe	American Tool & Machine Co.	3
*	17	Turret lathe 20-in. x 7-ft.	American Tool & Machine Co.	5
*	18	Turret lathe 34-in.	Gisholt Machine Co.	15
	19	Axle lathe, double	Pond Machine Tool Co.	25
*	20	Axle lathe, double	Putnam Machine Co.	35
*	21	42-in. car wheel lathe	Pond Machine Tool Co.	20
	22	69-in. driving wheel lathe	Niles Tool Works Co.	25
*	23	90-in. driving wheel lathe	Putnam Machine Co.	25
	24	Hydrostatic wheel press, 200-ton	Niles Tool Works Co.	† 7½
*	25	100-in. hydrostatic wheel press, 300-ton	Putnam Machine Co.	† 7½
*	26	Driving wheel quartering machine	Niles Tools Works Co.	5-5
	27	42-in. car-wheel borer	Pond Machine Tool Co.	10
*	28	18-in. x 36-in. horizontal boring machine	Betts Machine Co.	15
*	29	51-in. boring mill	Baush Machine Tool Co.	15
	30	72-in. boring mill	Pond Machine Tool Co.	25
	31	36-in. drill press		4
	32	36-in. drill press		4
	33	36-in. drill press		4
	34	36-in. drill press		4
*	35	30-in. drill press	J. E. Snyder	5
	36	6-ft. radial drill	Niles Tool Works Co.	4
*	37	5-ft. radial drill	Dreses Machine Tool Co.	6½
*	38	Two-spindle drilling machine	Bement, Niles & Co.	7½-7½
	39	30-in. x 30-in. x 8-ft. planer	New Haven Manufacturing Co.	7½
	40	30-in. x 30-in. x 8-ft. planer	Powell Planer Co.	7½
	41	42-in. x 42-in. x 12-ft. planer	Cincinnati Planer Co.	15
*	42	42-in. x 42-in. x 12-ft. planer	Pond Machine Tool Co.	15
	43	60-in. x 60-in. x 20-ft. planer	Pond Machine Tool Co.	20
	44	12-in. shaper	Hewes & Phillips	5
	45	24-in. shaper	Gould & Eberhardt	7½
*	46	24-in. shaper, Traverse head	Cincinnati Shaper Co.	7½
	47	12-in. slotter	Betts Machine Co.	6½
	48	19-in. slotter	Putnam Machine Co.	13
	49	Slab miller	Wm. Sellers & Co.	6
	50	6-in. pipe cutter	D. Saunders' Sons	7½
	51	Pipe cutter, I.X.L.	D. Saunders' Sons	3

GROUP-DRIVEN TOOLS—25 H. P. MOTOR.

	No.	Tool.	Maker.
	53	16-in. x 3-ft. lathe	P. Blaisdell Co.
	54	16-in. x 4-ft. lathe	
	55	18-in. x 3-ft. lathe	New Haven Manufacturing Co.
	56	36-in. x 16-ft. lathe	New Haven Manufacturing Co.
	57	Sensitive drill	
*	58	Sensitive drill	
	59	Universal milling machine No. 3	Brown & Sharpe.
*	60	Nut tapper, 6 spindle	National Machinery Co.
	61	1½-in. bolt cutter, double	Acme Machinery Co.
	62	1½-in. bolt cutter, double	Acme Machinery Co.
	63	2-in. bolt cutter, single	
*	64	Hack saw	
*	65	Tool grinder, No. 3 Universal	Sellers & Co.
	66	Twist drill grinder	
*	67	12-in. x 32-in. Universal grinder	Iroquois Machine Co.
	68	Emery grinder	
	69	Emery grinder	Safety Emery Wheel Co.
	70	Emery grinder, Universal	
	71	Grindstone	

BOILER SHOP.

INDIVIDUAL MOTOR-DRIVEN.

	No.	Tool.	Maker.	Motor H. P.
	75	Punch and shear, No. 3	Hilles & Jones Co.	†10
	76	Punch 13-16-in. hole in ¾-in.	Cleveland Punch & Shear Works Co.	† 5
*	77	Punch, No. 5	Hilles & Jones Co.	†15
*	78	Punch, No. 2, with spacing table	Hilles & Jones Co.	10
*	79	Punch, No. 2, horizontal	Hilles & Jones Co.	†10
*	80	Shear, No. 6	Hilles & Jones Co.	†15
*	81	Shear, No. 1, angle	Hilles & Jones Co.	†10
*	82	Straightening rolls, No. 2	Hilles & Jones Co.	15
	83	Bending rolls, No. 2	Hilles & Jones Co.	7½
*	84	Bending rolls, No. 4	Hilles & Jones Co.	25-10
	85	36-in. drill press		4

GROUP-DRIVEN—20 H. P.

No.	Tool.	Maker.
86	Staybolt cutter, 4 heads	Acme Machinery Co.
87	Coke crusher	
88	Flue cleaner	
89	Flue welder	
90	Tube swaging machine	
91	Flue cutter	

*New tools.
†Constant speed motors.

SHAW CRANES IN LOCOMOTIVE SHOPS AT MCKEES ROCKS, PA.—PITTSBURGH & LAKE ERIE RAILROAD.

Location in Shops.	Number of Cranes.	Capacity, in Tons.	Span, in Feet.	Lift of Hook, in Feet.	Number of Trolleys.	Number of Motors.	Motors—Horse-power. Main Hoist.	Trolleys.	Bridge.	Speeds in Feet Per Minute. Main Hoist. Loaded.	Main Hoist. Light.	Trolleys. Loaded.	Trolleys. Light.	Bridge. Loaded.	Bridge. Light.
1 Erecting	1	120	65 ft.	35 ft. 4 ins.	2	5	44	10	44	6	15	75	100	150	200
2 Erecting	1	10	62 ft.	27 ft. 4 ins.	1	3	22	4½	7½	20	50	100	125	250	300
3 Machine	1	7½	46 ft. 3 ins.	19 ft. 6 ins.	1	3	18	4½	7½	24	60	100	125	250	300
4 Boiler	1	30	47 ft. 10 ins.	24 ft. 1½ ins.	1	3	35	6	22	10	25	100	125	200	250
5 Boiler	2	10	43 ft. 10 ins.	20 ft. 11½ ins.	1	3	22	4½	7½	20	50	100	125	250	300

Speeds in table are guaranteed speeds. Light load speeds actually obtained were:

	(1)	(2)	(3)	(4)	(5)
Bridge	350	500	500	500	450
Trolley	200	300	300	250	250
Hoist	17	70	80	26	60

passing from one voltage to the next, especially in the armatures of large motors. This is prevented by the introduction of resistance in series with the armature as the controller moves to a new voltage notch. This resistance is short-circuited automatically as soon as the field magnetism and the speed of motor have had an opportunity to adjust themselves to the new conditions, and the controller drum can thus be moved rapidly through a large range in speed notches without causing injurious sparking at the motor brushes or in the controller.

Three views of this controller, two with the cover removed, are shown in the half tone. It is of good mechanical design and adapted to hard and constant service. The contacts are mounted on semi-circular metallic rings which are fastened to a wooden drum. These rings are accurately located by means of keys in the drum and tongues on the rings, which fit into grooves turned in the surface of the drum and any section of controller contacts can thus be easily replaced without dismounting the entire drum. The contact fingers are very strongly constructed of drop forged copper, and are fitted with adjusting screws for regulating the pressure of the finger against the contact. The controller itself is compact and operates both forward and reverse motions with but one drum. There are twenty-three forward speeds giving a total range of 13 to 1, but this total range is only used for very special cases, the three lower speeds, as already stated, being used ordinarily for starting and the two upper speeds being used where it is necessary to obtain a greater range at reduced power. The working speed range is 4 to 1, divided into 18 speed steps with an average speed increment of 9 per cent. and there are four backward speeds with a speed range of 5 to 1.

Attached to the top of the controller is what is known as the quick-break device, the action of which, being similar to that of the ordinary quick-break switch, causes the controller drum to move at a high speed in breaking the connections and making new ones independent of the rapidity of motion of the handwheel. In passing from one voltage to another, the circuit is simultaneously broken in eight different places, which renders the contacts especially free from arcing and burning. Resistance is also inserted in the armature circuit, which is afterward automatically short circuited. The length of time which this resistance remains in circuit is regulated by means of an adjustable air dashpot. The quick-break device is interlocking and makes it impossible for motor to stop between controller notches. The cover is designed so as to be easily and quickly removed when necessary for inspection. The drum can also be readily removed without disturbing any of the wiring connections.

CRANES.

The location and arrangement of the traveling cranes have been considered in connection with the construction of the various shop buildings and the general features of these cranes are condensed in the accompanying table.

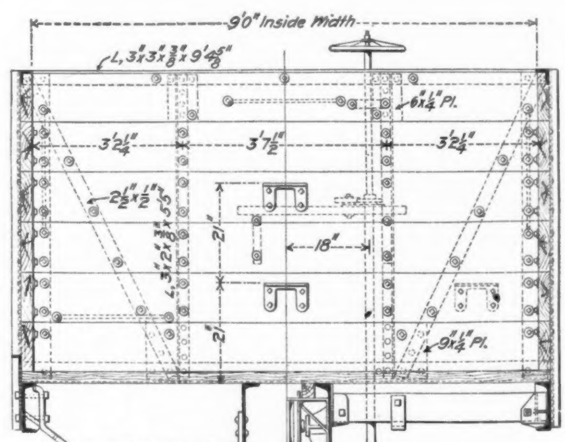
40-TON STEEL UNDERFRAME HOPPER CAR.

This engraving illustrates a steel underframe hopper car designed by Mr. George I. King, of the Middletown Car Works, and built by that company for the Berwind-White Coal Company. In its general features it follows the plan so successfully employed in the construction of the very satisfactory composite coal cars designed by Mr. C. A. Seley, for the Norfolk & Western Railway, when he was mechanical engineer of that road. It employs 15-in. 33-lb. channels as center sills and 10-in., 20-lb. channels as side sills. The side framing, which assists in carrying the load, is built of 7-in. channels for the vertical members and 3 by 2 by ⅜-in. angles for the diagonals. In the substitution of angles, in place of channels, for the diagonal members, this construction differs from that of the Norfolk & Western cars. It also differs in many of the details, but the important similarity is in the use of the side frames in assisting to carry the load. The coping angle which forms the top member of the side truss is 3 by 2½ by ½ in. and the junctions with this member are made with rectangular gusset plates. The general dimensions of this car are as follows:

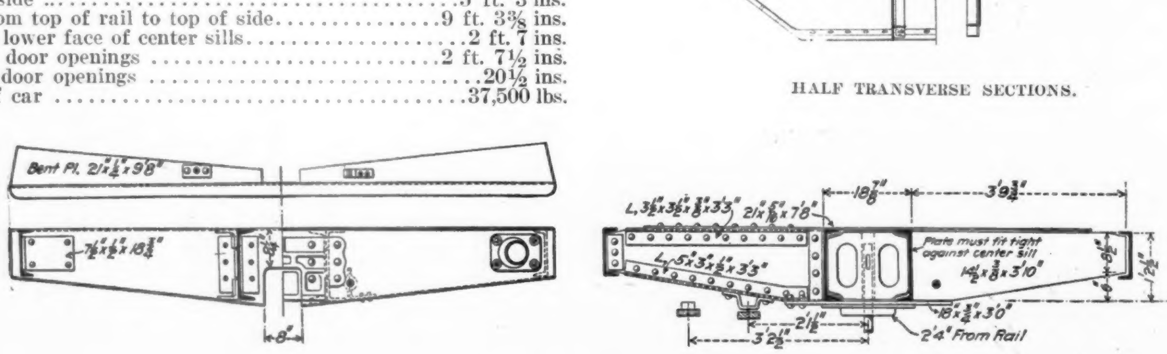
Length over end sills	29 ft.
Length inside	26 ft. 6 ins.
Width over side sills	9 ft. 5 ins.
Width inside	9 ft.
Height inside	5 ft. 3 ins.
Height from top of rail to top of side	9 ft. 3⅜ ins.
Height to lower face of center sills	2 ft. 7 ins.
Length of door openings	2 ft. 7½ ins.
Width of door openings	20½ ins.
Weight of car	37,500 lbs.

extending a short distance towards the end of the car, and to these the corner bracing is riveted. The center sills are continuous through the bolsters and the bolsters are in the form of built-up diaphragms. The door operating mechanism is placed between the center sills.

Instead of extending the center sills to the ends of the car, they stop beyond the bolsters and the draft gear is secured to



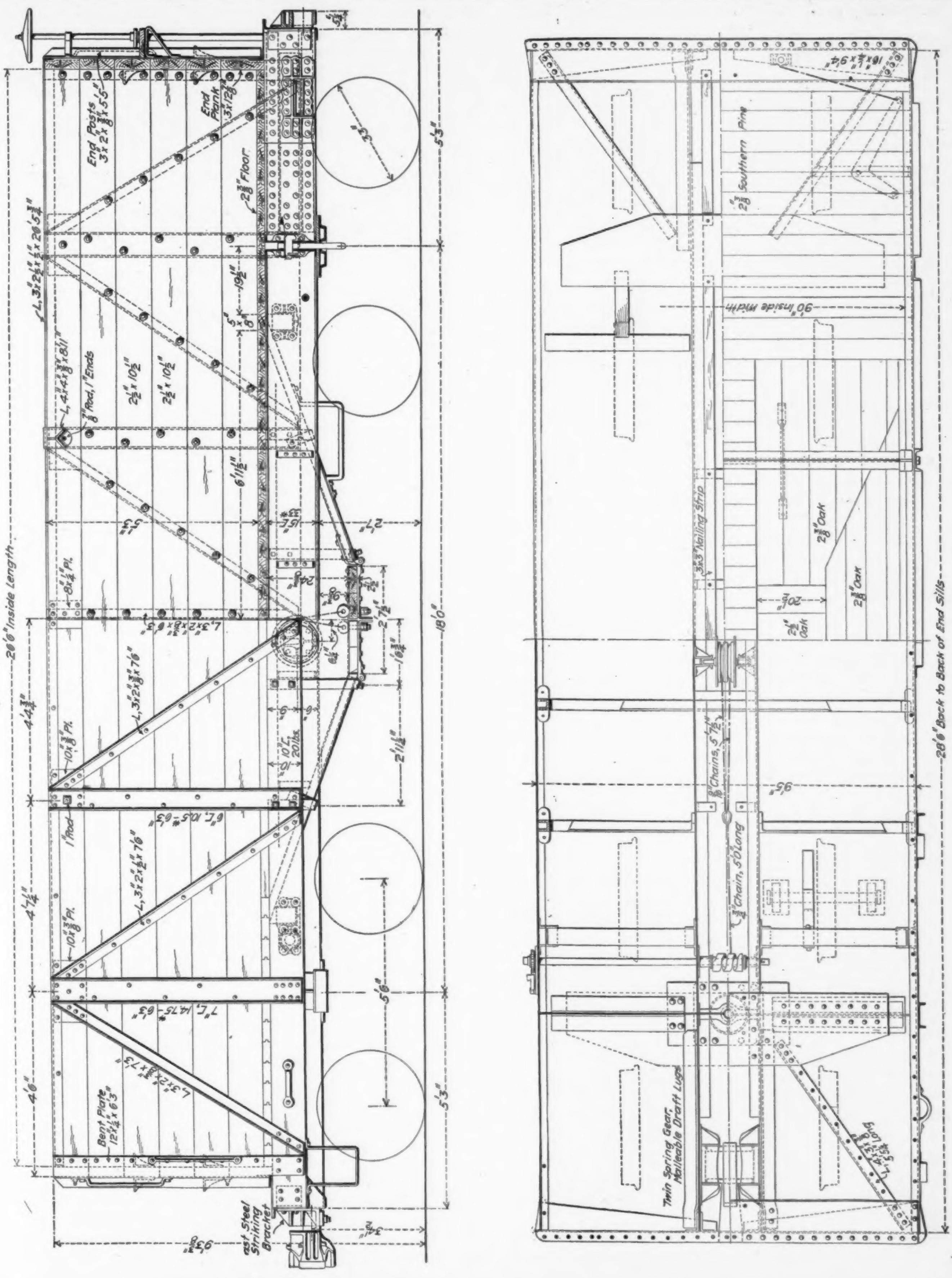
HALF TRANSVERSE SECTIONS.



END SILL AND BOLSTER.

The end sill is a flanged plate which is surmounted by a deck plate flanged up against the end plank of the car. The body bolster is of plates and angles as shown in the detailed engraving. The bolsters are surmounted by long cover plates draft sills of plates spliced to the center sills. In case of damage to the draft gear the draft sills may be renewed without disturbing the center sills.

The coal company required a 40-ton car mounted on the Penn-



PLAN, ELEVATION AND SECTION OF 40-TON STEEL UNDERFRAME COAL CAR.—MIDDLETOWN CAR WORKS.

sylvania standard 50-ton trucks in order to favor the wheels by a reduction of wheel loads. While the reasons for composite construction instead of building the cars entirely of steel cannot be definitely stated a rather significant number of composite cars have been built recently. This seems to indicate a desire to guard against corrosion of equipment which is to be used exclusively in coal service.

These drawings were supplied by Mr. George I. King, vice-president and general manager of the Middletown Car Works.

ANOTHER SUCCESS OF GASOLINE ENGINES.—Crossing the English Channel, doing 25 miles in 1 hour and 7 seconds, in a boat less than 40 ft. long, driven by gasoline engines, is a noteworthy performance. In the recent race the Channel turbine steamer "Queen" was distanced, and the French torpedo boat following the leader had to "open up wide" to keep abreast. The internal combustion motor is doing things on the water as well as on the land which are not being done by steam. It will bear close watching for further developments.

IMPRESSIONS OF FOREIGN RAILROAD PRACTICE.

EDITORIAL CORRESPONDENCE.

CREWE, England.

At Crewe I found 8,000 men employed, at the time of my visit, in the locomotive department solely. These shops are very large and interesting in many ways, but they have grown, like many shop plants, by accretion. This plant is unique with respect to the amount of manufacturing done, which includes the making of boiler plates, rolling of rails, the making of steel castings and manufacturing of the signal and interlocking apparatus and a variety of other things used on the road. It strikes a visitor as a little strange that a railroad should manufacture its steel plate and rails, because plants for these purposes must necessarily be relatively small and consequently difficult to operate economically and keep up to date. A visit to one of these large English shop plants is exceedingly instructive and emphasizes the importance of studying shop conditions and shop progress with a view of keeping up to standards set by industrial establishments.

At Crewe I found (and it was the only place in my travels) locked doors between shops. The purpose is to prevent unnecessary wanderings of the men, but it must be a very great inconvenience to the officials and those who must necessarily go from one shop to another, and gives an unpleasant impression of espionage.

The amount of milling done in the leading English shops is surprising. No new planers are bought for Crewe, and the old ones are used up as fast as possible. A large tool room is nearly exclusively given up for making cutters for milling machines. Main and side rods are milled in piles of four or more on profile milling machines, the cutters following formers. The work is rapidly and well finished, the rods going directly into the erecting shop with no hand finish. I saw, however, a great deal of hand finishing, by draw-filing, in other shops. Valves and driving boxes are made of solid bronze and are finished by special milling tools, making them absolutely interchangeable. The pin holes in valve motion work are lapped out for the pins; this produces very accurate fitting and reduces the work in the erecting shop. Piston rods have no hand work, and rods in repairs are all finished by grinding.

There is a great deal of old machinery here which is very much crowded, and the number of belts in these shops will some day be very greatly reduced. The shops themselves will light up the heavens very beautifully if they happen to take fire on a dark night. The new machinery seems to be remarkably strong and heavy, with no stinting of material. The milling machines are particularly rigid, and I should say that rather more attention is paid to strength and rigidity than to feed and driving mechanism. I found comparatively few boring mills at Crewe in the older shops and a correspondingly increased use of lathes. Piecework is used throughout on repetitive jobs, and the shop work is arranged as nearly as possible on a manufacturing basis. The rather close adherence to routine methods is possible because of the relatively small number of standard locomotives and the very marked efforts in the direction of interchangeability of the principal parts in several different classes of locomotives. One does not find here some four or five different kinds of eccentrics or eccentric straps piled up in front of a machine.

The boiler work at Crewe causes a sigh of admiration, because here are real boiler makers in abundance, and their work is finely fitted and finished. It is safe to say that the men testing these boilers under hydraulic pressure do not require umbrellas or oil-skins—although I did not have the good fortune to see one tested. While labor saving machinery is used to a certain extent, most of the work is done by hand. The staybolt work is done with special care and copper staybolts are used exclusively. Boiler tubes, as a rule, are beaded over only at the back end, and it is quite common to find only a portion at this end so treated. The smokebox ends are usually not beaded at all. A characteristic of boiler shops over here is the use of flanging presses and formers, and in this the drafting room helps the shop by reducing the number of standard sheets requiring flanging. I should say that the American roads could advantageously send a representative over here to study this matter of duplication of parts in boilers and running gear.

English locomotive men have no use for the American bar-frames, and I was attacked on this question everywhere. I fought for the American frame on principle, but—I learned something. The criticism is not on the bar-frame itself so much as on the difficulty of forging, or casting, a frame of this type so that it will be free from initial stresses. I think there is a good deal of prejudice over here in this matter, but these plate frames cannot be examined thoughtfully without reaching the conclusion that they have some excellent points. Plate frames are now cut away so that they do not render the engine inaccessible, and the plates offer the advantage of homogeneity. The strong point of English frames, however, is not in the plate so much as it is in the bracing, which is exceedingly deep and rigid. The frames are themselves deep and amply rigid against vertical stresses. They are made rigid against twisting by three substantial steel castings, which are nearly as effective as the cylinders. One of these is the motion plate supporting the guides and the others are in the form of the belly braces and cross braces at the front end of the firebox. These act as the diagonal braces between two deck bridge girders and seem admirably suited to provide for the exceedingly heavy stresses received by the flanges of the drivers when striking curves. Judging from the answers to my questions, nothing on an English locomotive has ever broken since the time of Stephenson, and nothing ever will break, but I am quite sure that, except in the case of very old locomotives, there is very little trouble here with broken frames.

On this road, as on nearly all others in this country, there are no adjustable parts in the smokebox except the petticoat and stack. The petticoats are usually cast integral with the stack, and, like the practice of the Caledonian Railway, when once adjusted for a new engine no provision is made for subsequent change. Of course, they throw "fire" to some extent, but not as much as we would expect.

The Crewe shops are on a longitudinal track basis, which is the usual rule over here.

The painting of new engines requires two weeks, but is not renewed for about six years. Fifteen months is the usual period between general repairs. This road builds all its new engines and usually builds about 70 per year for renewals.

On the London & Northwestern the engine men both report from one to one and a half hours before their engine is to go out. They attend to taking coal and water, oiling and inspecting, before the run. They also stay with the engine a half-hour after getting in from a run, and make a very careful inspection, being held responsible for reporting the condition of the engine in every respect and for reporting in writing in the work book anything requiring attention. As a rule they remain about the engine when repairs are being made, to see that the work is satisfactorily done. Contrast this sort of interest with that found in connection with the pooling system!

The shop men in England are a comfortable lot. They take life easily and certainly impress the visitor with the idea that they do not intend to work hard; in fact, in going about the shops the men seen appear to be slow and inclined to make their work last as long as possible. The absence of labor-saving "kinks" and devices, such as hoists over the machines, tends toward a great deal of unnecessary manual labor.

English foremen are officials with considerable dignity. I met several Whitworth scholars among them and a number who were technical school graduates. They are personages of considerable importance, and the workmen hold them in apparent awe, which is in marked contrast to the freedom and democracy of an American railroad shop. The foreman here is not "Bill," "Fred," "Charlie" or "Dick." He is Mr. So and So, with a touch of the cap. The works manager of an English road is as he ought to be, a real official, with his duties confined, as

they ought to be, to the shops themselves. English roads do not have the counterpart of our master mechanic with responsibilities of various kinds over shops, roundhouses, engineers and firemen, wrecking crews and all, with too little help and depending upon general foremen for important shops.

British locomotives are usually adapted to hauling light loads. They are well adapted for it, and have been developed on this basis. The time has now come, however, when something new must be done. Trains are becoming heavier, and as passenger equipment improves, as it must along the lines of "corridor" cars, much greater weights will prevail. Furthermore, competition among the various lines will bring this heavier equipment very rapidly and the English locomotive superintendent will soon face a very difficult problem, which amounts to the provision of greatly increased capacity without exceeding the narrow limits of clearances. Across the Channel the same problem was foreseen some years ago, and French roads have studied it and provided for it effectively. This has not escaped the attention of progressive English railroad men, and the Great Western is now studying the De Glehn compound by aid of an engine built by the Société Alsacienne de Constructions Mechanique, from the drawings of the latest 4-4-2 engine of the Northern Railway of France. My understanding of the reason for this purchase of a foreign engine is this: The Great Western has recently produced at Swindon a new design of 4-6-0 passenger engine. It is a beautiful machine and represents the knowledge and experience gained on this road in the construction of single expansion locomotives. In fact, it is the best single expansion locomotive that Mr. Churchward can build within the limits prescribed by the demands of the road. Wishing to know what may be expected from compounding, he bought a De Glehn compound, believing this type to represent the best and most advanced method of compounding. In securing a compound he desired to obtain one which would be comparable in weight with his own design. The results of the comparison will be interesting. It will be necessary, however, to operate the French engine in the French way, or it will not show what it can do. Undoubtedly this will not be overlooked.

The Great Western is not the only road which is making a study of Continental practice. A locomotive superintendent of another prominent road told me that he believed it would soon be necessary to apply the De Glehn principle to his practice in order to keep pace with the demands made upon him by the management. It is worth remarking that this official did not say that he thought compounding would be necessary, but that the De Glehn compounding was needed. He proceeded to explain that, because the work required of a locomotive varies with frequently changing conditions of the road, the design of the locomotive should provide means for adjusting the engine to the conditions, and this, he thought, was best accomplished by the four-cylinder compound with independent valve gears. I was considerably impressed by this frank statement of a man who would not look to a foreign country for ideas in locomotive construction if he could avoid it. He wished me to withhold his name, and went on to say that he had gone as far as he could on present lines. Little was left to be gotten out of boilers or boiler accessories, there was not much to be expected in the way of improvements in valve gear, and he did not believe it possible to greatly improve simple engines unless superheating should prove successful. If it should, he would adopt it, and even then he thought compounding necessary. On drawing him out a little further, he expressed the opinion that it would be necessary to adopt every refinement, within reasonable limits, which would increase the capacity of locomotives by increasing the effectiveness of a pound of steam. He said: "We must not hesitate to complicate our locomotives, and we must do every possible thing to educate and encourage the men who handle the engines, so that they will get the work out of them. We need scientific locomotives and specially educated men to run them. We are now up against a stone wall, and these things we must do."

His words are quoted exactly as possible, and they are worthy of thoughtful consideration in every country where railroad transportation is an important factor. Some instructive and intelligent locomotive designing is to be done in England in the near future.

I may be pardoned for recording these particular notes with considerable pleasure, because the ideas are so closely in accord with my own. G. M. B.

(To be continued.)

PERSONALS.

Mr. Mord Roberts has resigned as superintendent of machinery of the Kansas City Southern Railway.

Mr. C. H. Bowers has been appointed assistant master car builder of the Canadian Pacific lines east of Port Arthur.

Mr. A. Struthers has resigned as master mechanic of the El Paso & Southwestern at Douglas, Arizona.

Mr. W. E. Killen has resigned as superintendent of motive power of the Chicago, Peoria & St. Louis at Jacksonville, Illinois.

Mr. M. D. Stewart has resigned as master mechanic of the Rio Grande, Sierra Madre & Pacific to accept a position as master mechanic on the Chicago, Peoria & Pacific.

Mr. J. W. Oplinger has been appointed superintendent of motive power of the Atlantic Coast Line, with headquarters at Savannah, Ga., to succeed Mr. W. H. Young.

Mr. F. A. Chase, general master mechanic of the Missouri Lines of the Chicago, Burlington & Quincy, has been appointed general mechanical inspector with headquarters at St. Louis, Mo.

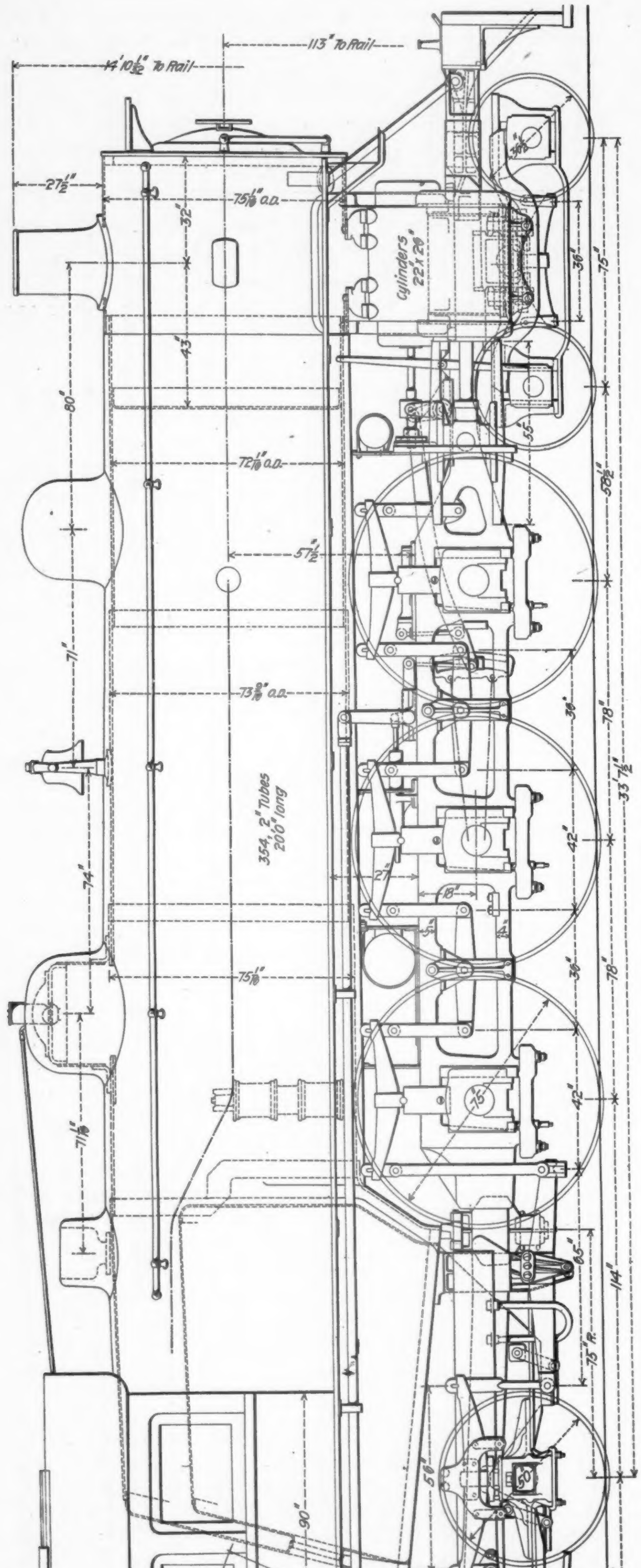
Mr. W. E. Symons, mechanical superintendent of the Gulf Lines of the Atchison, Topeka & Santa Fe, has been appointed superintendent of motive power of the Kansas City Southern, with headquarters at Pittsburg, Kan.

Mr. Thomas Paxton has resigned as master mechanic of the St. Louis, Iron Mountain & Southern to become master mechanic of the El Paso & Southwestern Railway, with headquarters at Douglas, Ariz.

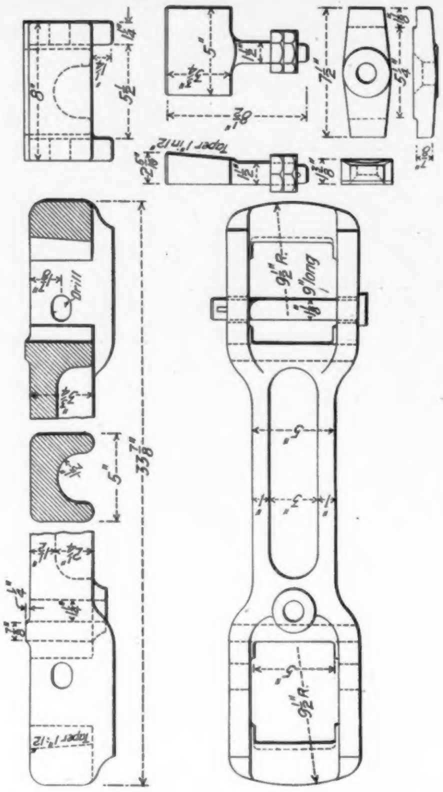
Mr. A. Harrity has resigned as master mechanic of the Atchison, Topeka & Santa Fe at Raton, New Mexico, and has been appointed mechanical superintendent of the Gulf, Colorado & Santa Fe to succeed Mr. W. E. Symons.

Mr. A. B. McHaffie has been appointed master mechanic of the Intercolonial Railway of Canada, with headquarters at Moncton. He is promoted from the position of foreman of the locomotive shops at that point.

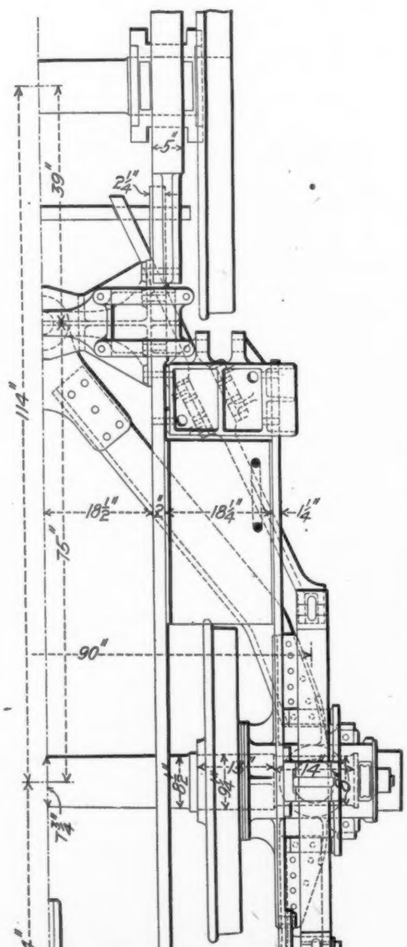
John R. Slack, formerly superintendent of motive power and recently appointed assistant to the general superintendent of the Delaware & Hudson, died in New York, August 1, at the age of 41 years. Mr. Slack was educated at Columbia College and Stevens Institute of Technology. He began railroad work as an apprentice on the New York Central and became mechanical engineer of that road in 1890. In 1898 he went to the Central Railroad of New Jersey as mechanical engineer, and in 1894 was appointed assistant superintendent of motive power of the Delaware & Hudson. In 1902 he was promoted to the head of the department and in March last was appointed assistant to the general superintendent. He will be sadly missed by many whose respect and friendship he gained by his attractive personality.



PASSENGER LOCOMOTIVE.—MICHIGAN CENTRAL RAILROAD.



DETAILS OF PEDESTAL BINDER.

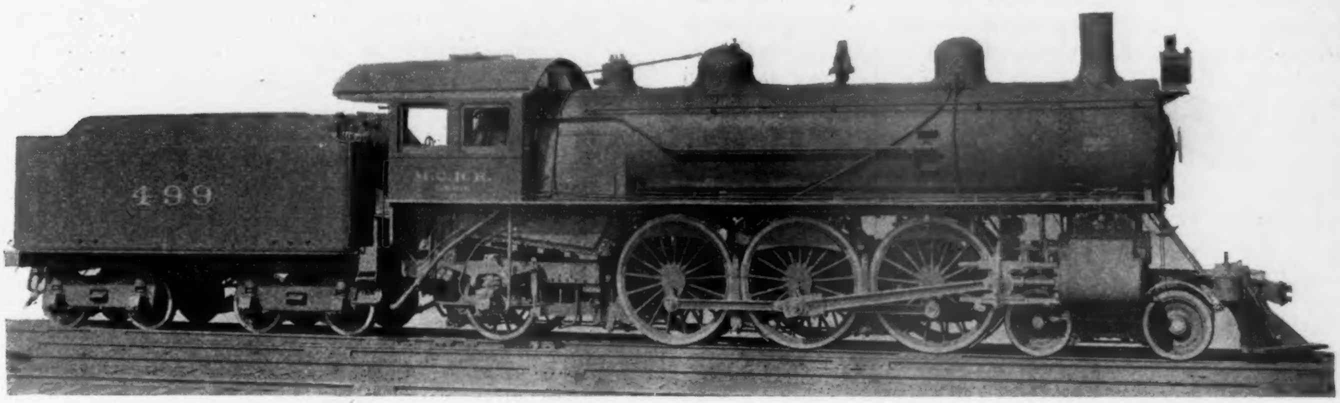


PLAN VIEW OF TRAILER TRUCK.

PASSENGER LOCOMOTIVE.—MICHIGAN CENTRAL RAILROAD.

E. D. BRONNER, *Superintendent Motive Power*.

AMERICAN LOCOMOTIVE COMPANY, *Builders*.



PASSENGER LOCOMOTIVE, MICHIGAN CENTRAL RAILROAD.

E. D. BRONNER, *Superintendent Motive Power.* AMERICAN LOCOMOTIVE COMPANY, SCHENECTADY WORKS, *Builders.*

PASSENGER LOCOMOTIVE, MICHIGAN CENTRAL RAILROAD.

4-6-2 (PACIFIC) TYPE.

The Michigan Central has in service four very powerful six-coupled passenger locomotives from the Schenectady Works of the American Locomotive Company. These engines closely resemble those of the same type for the New York Central, illustrated in this journal in March, 1904, page 87, but they are somewhat heavier. In the accompanying tables the comparison of total weights and heating surfaces of a number of recent large passenger locomotives are given, and also some ratios of the different factors of the new Michigan Central engines:

COMPARISON WITH OTHER LARGE PASSENGER LOCOMOTIVES.

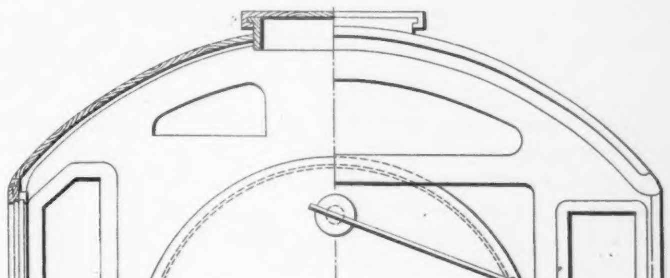
Road.	Engine Number.	Total Weight.	Total Heating Surface.	Total Weight Divided by Heating Surface.
C. & A.	602	221,550	3,053	72.5
M. C.	499	221,000	3,894	56.7
C. & A.	601	219,000	4,078	53.7
N. Y. C.	2,794	218,000	3,757	58.2
El Paso & Southwestern	——	209,500	3,818	54.8
Northern Pacific	284	202,000	3,462	58.3
A., T. & S. F.	1,000	190,000	3,738	50.1
C. & O.	147	187,000	3,533	52.9
L. S. & M. S.	650	174,500	3,343	52.2

RATIOS OF MICHIGAN CENTRAL LOCOMOTIVES.

Heating surface to cylinder volume	= 341
Tractive weight to heating surface	= 36.1
Tractive weight to tractive effort	= 4.93
Tractive effort to heating surface	= 7.31
Heating surface to grate area	= 77.5
Heating surface, percentage of tractive effort	= 13.6
Total weight to heating surface	= 56.7

It is interesting to note the advance in capacity over the recent passenger locomotives of the 4-4-2 type built last year for this road and illustrated in this journal in January, 1903, page 33. The present design is only 550 lbs. lighter in total weight than the heaviest of passenger locomotives which are running on the Chicago & Alton Railroad. In 1902 the Baldwin Locomotive Works built some 2-8-0 passenger engines for the Colorado Midland, with 74-in. boilers. These Michigan Central engines, with 72 1-16-in. boilers, are next to these in having the largest boilers in passenger service. They have long, straight boilers with 354, 2-in. tubes 20 ft. long and having ¾-in. spaces between the tubes. The heating surface is 3,894 sq. ft., which closely approaches that of the Chicago & Alton engine of this type, built a year ago, with the largest heating surface yet given to any passenger locomotive. This boiler has a 4½-in. mud ring on all sides. It has a liberal number of flexible staybolts in the outside rows surrounding the narrow water spaces. A ring of these staybolts, 64 in number, all around each side of the firebox and in the corners, 40 of them in the other rows on the back head and 44 in the throat sheet, are expected to reduce the staybolt breakage.

Special care has been taken to brace the frames with broad, flat braces over the front driving axle, between the second and third driving axles and at the pivot for the trailing axle radius bar. The bottom rails of the frames are tied across the engine at the forward and main driving boxes. There is no splice in the frames except at the rear of the rear driving boxes. Special attention is directed to the new keyed pedestal tie binders for the frame jaws. These permit of strong and yet adjustable construction at these vital points. This binder



HALF REAR ELEVATION AND SECTION.

was developed by Mr. Francis J. Cole of the American Locomotive Company.

These engines have piston valves with inside admission and direct motion. In the plan view the fork connection at the back end of the transmission bar and the double link lifters are shown.

The trailer trucks are similar to those of the recent New

York Central engines of this type. They have, however, a better arrangement for taking out the truck boxes by means of a removable pedestal tie which was not originally provided in the earlier engines. These trucks have angle bar frames and radius bars 75 ins. long, measured on the center line of the engine. In order to connect the rear equalizers with the outside boxes of the trailer truck and the inside driving boxes, the levers are placed at an angle, with the fulcrums under the front firebox supports. These fulcrums form the connection between the main and short outside auxiliary frames at the trailer trucks. A spring seat and 2-in. rollers provide for easy lateral movement of the trailer trucks.

In studying this design the high ratio of tractive weight to tractive effort should be noted. The engine should not be "slippery" under any ordinary condition of rail. It is noteworthy that strength has not been sacrificed in any particular in order to reduce weight.

Mr. E. D. Bronner, superintendent of motive power of the Michigan Central, states that these engines are to haul very heavy trains such as No. 31, which leaves Chicago at 9.00 p. m. and arrives at Buffalo at 7.20 a. m., 535.2 miles in 10 hours, 20 minutes, at an average speed of 51.8 miles per hour. This train usually consists of 16 cars and weighs 600 tons behind the tender. The grades on the Canada division are very light, while on the United States division there are some of 36 ft. to the mile. In this journal for January, 1903, page 33, a remarkable run with this train hauled by the Class K, or 4-4-2-type, locomotives was described. The larger engines, Class L, are expected to handle the train comfortably, whereas the smaller engines are put to the limit of their capacity. In this run there are 15 regular station stops and, taken as a whole, it is very severe service. Readers are referred to the description of the work of the 4-4-2 engines for the particulars of a portion of the remarkable previous performance of one of them.

In the following table the chief dimensions are given:

PASSENGER LOCOMOTIVE, MICHIGAN CENTRAL RAILROAD.
4-6-2-TYPE.

GENERAL DIMENSIONS.

Gauge	4 ft. 8½ ins.
Fuel	Bituminous coal
Weight in working order	221,000 lbs.
Weight on drivers	140 500 lbs.
Weight engine and tender in working order	343,600 lbs.
Wheel base, driving	13 ft.
Wheel base, rigid	13 ft.
Wheel base, total	33 ft. 7½ ins.
Wheel base, total, engine and tender	60 ft. 5 ins.

CYLINDERS.

Diameter of cylinders	22 ins.
Stroke of piston	26 ins.
Horizontal thickness of piston	6½ ins.
Diameter of piston rod	3¾ ins.
Kind of piston-rod packing	U. S. metallic, with Gibbs vibrating cup

VALVES.

Kind of slide valves	Piston
Greatest travel of slide valves	1¼ ins
Outside lap of slide valves	1 in.
Inside clearance of slide valves	¼ in., ⅛ in.
Lead of valves in full gear	Line and line in full forward motion, one-quarter lead at one-quarter stroke
Kind of valve-stem packing	U. S. metallic

WHEELS, ETC.

Number of driving wheels	6
Diameter of driving wheels outside of tire	75 ins.
Material of driving-wheel centers	Cast steel
Thickness of tire	3½ ins.
Driving-box material	Cast steel
Diameter and length of driving journals	9½ ins. diameter x 12 ins.
Diameter and length of main crankpin journals:	(Main side, 7½ x 4¾ ins.) 7 ins. diameter x 6½ ins.
Diameter and length of side-rod crankpin journals:	Forward and back, 5 ins. diameter x 4½ ins.
Engine-truck journals	6 ins. diameter x 12 ins.
Engine-truck wheels	36 ins.
Trailer wheels, diameter	50 ins.
Trailer journals	8 x 14 ins.

BOILER.

Style	Straight top, radial stay
Outside diameter of first ring	72 1-16 ins.
Working pressure	200 lbs.
Thickness of plates in barrel and outside of firebox	23-32, ¾, ½, 9-16 in.
Firebox, length	96⅛ ins.
Firebox, width	75¼ ins.
Firebox, depth	Front, 79½ ins.; back, 65¾ ins.
Firebox, material	Carbon
Firebox plates, thickness:	Sides, ⅜ in.; back, ⅜ in.; crown, ⅜ in.; tube sheet, ½ in.
Firebox, water space	Front, 4½ ins.; sides, 4½ ins.; back, 4½ ins.
Firebox, staybolts	Ulster special iron, 1-in. diameter W. S.
Tubes, number	354
Tubes, diameter	2 ins.
Tubes, length over tube sheets	20 ft.
Fire brick, supported on	Water tubes
Heating surface, tubes	3,690.6 sq. ft.
Heating surface, water tubes	23.6 sq. ft.
Heating surface, firebox	180.3 sq. ft.
Heating surface, total	3,894.5 sq. ft.
Grate surface	50.23 sq. ft.
Exhaust pipes	Single
Exhaust nozzles, diameter	5⅜, 5⅝, 5⅞ ins.
Smokestack, inside diameter	18 ins.
Smokestack, top above rail	14 ft. 10 1-32 ins.

TENDER.

Style	Water bottom
Weight, empty	52,600 lbs.
Wheels, number	8
Wheels, diameter	36 ins.
Journals, diameter and length	5½ ins. diameter x 10 ins.
Wheel base	18 ft.
Tender frame	10-in. channels, 11-16-in. web
Tender trucks	Fox pressed steel, floating bolster
Water capacity	6,000 U. S. gals.
Coal capacity	10 tons

PERFORMANCE AND REPAIRS OF "BIG LOCOMOTIVES."

The opinions concerning "Big Locomotives," printed in the June number of this journal, have attracted the attention of many operating officers and it is to be hoped that a reduction in the too general practice of overloading will result.

Several officers were sufficiently interested to make an effort to ascertain the cost of repairs of various classes of locomotives and to investigate the records of "engine failures." These figures are usually not available in the customary methods of keeping accounts and in order to know positively the standing of the large locomotives an analysis was prepared by the officers of the Chicago, St. Paul, Minneapolis & Omaha Railway. Mr. A. W. Trenholm, general manager, has transmitted a statement prepared by Mr. J. J. Ellis, superintendent motive power and machinery, which is reproduced in full with the accompanying diagrams.

A careful study of these diagrams carries the conviction of the necessity for such comparisons in order to determine with intelligence the proper motive power policy of a road. The observations of Mr. Ellis are as follows:

"Are big locomotives satisfactory?" From a motive power standpoint I should say they are not, when the weight greatly exceeds 225,000 lbs. The curves in Fig. 1 indicate that the cost of repairs increases very rapidly with the weight of the locomotive, the increase being greatest in passenger engines. The upper curve of Fig. 2 shows that the cost of coal consumed per thousand ton miles decreases very rapidly with the increased weight of the locomotive up to a certain limit, after which the curve is nearly parallel with the base line; then again slightly rising at engines weighing 275,000 lbs., showing that the limit of weight which gives greatest fuel economy has been exceeded. The same is nearly true as to cost of oil per thousand ton miles shown on the same sheet.

"Are locomotive failures increasing as the size of locomotives increases?" This can be answered by referring to the table of figures showing the engine failures on the Wisconsin Division and Minnesota & Iowa Division for four months, including December, 1903, and the first three months of 1904. It will be observed that on the Wisconsin Division, where the engines employed in road service are about equally divided between light and heavy power, that 91.2 per cent. of all failures during these four months are against the heavy power. On the Minnesota & Iowa Division 23.1 per cent. of the power weighs more than 225,000 lbs. per locomotive and 26.9 per cent. of the failures are due to this class of power. Why there is such a difference in the per cent. of failures chargeable to large locomotives on the Wisconsin and Minnesota & Iowa Divisions, I am unable to say. Whether it is due to the fact that engines are big, or to overloading, is a matter of conjecture.

If the difference between the tonnage hauled and a dynamometer car rating was known for the two divisions, it might throw some light on the subject. A very important part of the first question, from an operating standpoint, is the relative cost per thousand ton miles, for engine and train crews, when working with light and heavy locomotives. A curve should be plotted similar to that of the cost of coal and oil consumed and would be a very valuable addition to this data and

something that should be known. We could do this here if we had the cost for train crews—we can, of course, obtain from our records the cost as to engine crews.

"All the information here presented would indicate that from a motive power point of view a maximum limit of weight for

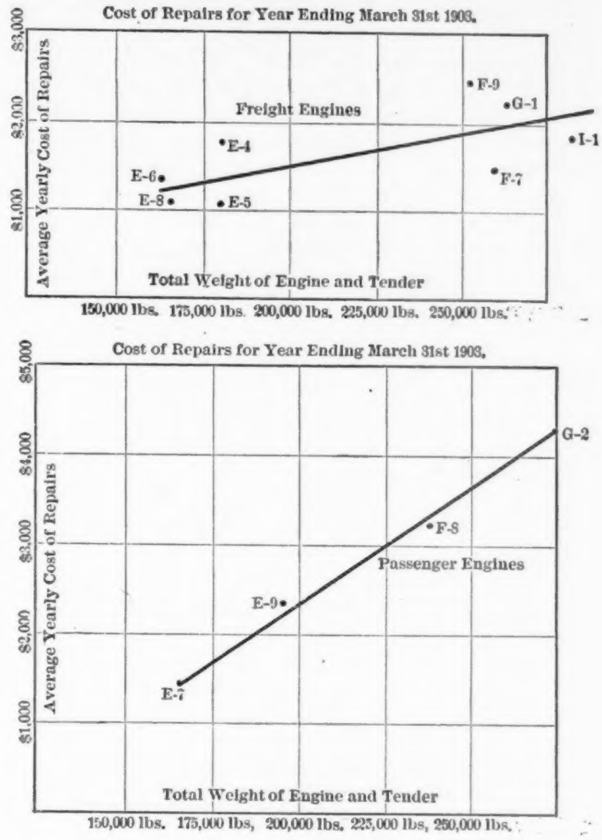


FIG. 1.

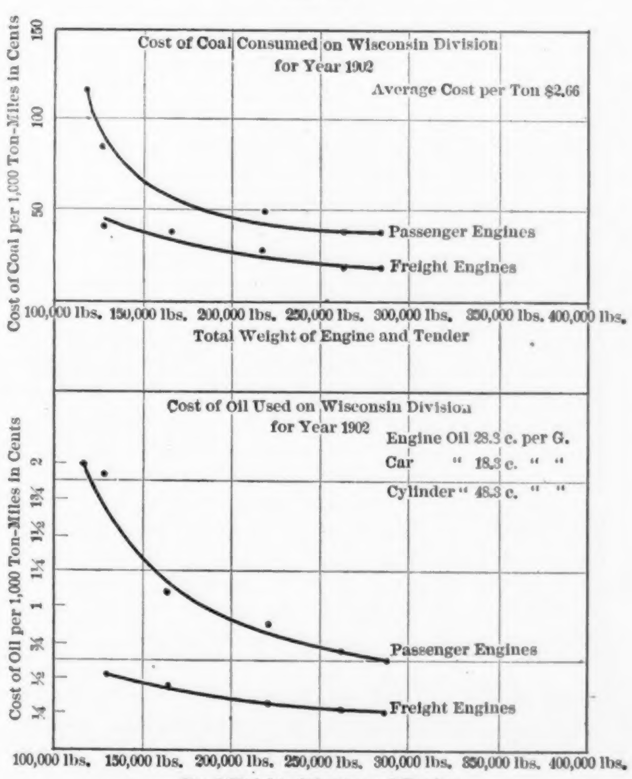


FIG. 2.

locomotives in road service should not far exceed 225,000 lbs., in order to procure the greatest economy in fuel and oil consumption, cost of repairs, and minimize engine failures.

"Please note that Fig. 2 shows the cost of coal and oil for the year 1902. The reason for taking 1902 instead of 1903 is on account of the fact that locomotive statistics compiled in our car service agent's office show the oil consumed in 1902, but does not give the figures for 1903. While we would rather have used 1903 figures, it probably would not change the comparative cost."

AVERAGE YEARLY COST OF REPAIRS.

Class	Type of Engine.	No of Engs in Aver'ge	Aver'g Age	Total Weight Eng. & Tender	Tractive Power	Av'rge Cost of Reprs. per yr.
PASSENGER ENGINES.						
E-7	4-4-0	6	16	166,100	12,920	$1,432.92
E-9	4-6-0	6	13	196,000	16,520	2,310.37
F-8	4-4-0	14	6	238,200	18,040	3,222.00
G-2	4-6-0	3	3	275,050	24,115	4,315.59
FREIGHT ENGINES.						
E-4	4-6-0	5	19	178,600	15,480	1,711.43
E-5	4-4-0	10	21	178,600	13,820	1,041.92
E-6	4-4-0	23	17	164,100	13,820	1,357.50
E-8	4-4-0	10	16	166,100	14,280	1,082.88
F-7	4-6-0	2	7	258,700	22,650	1,493.12
F-9	4-6-0	10	6	251,600	22,320	2,415.33
G-1	4-6-0	13	4	264,000	25,090	2,235.50
I-1	4-6-0	16	2	279,850	29,120	1,877.50

ENGINE FAILURES.

Year	Month	No. Failures Dur. Month	No Road Engs. Assigned to Division	% of Road Engin's ov'r 225,000 on Div.	% of Failures on Eng's over 225,000
WISCONSIN DIVISION.					
1903	Dec.	36	84	51.8	91.7
1904	Jan.	36	83	48.9	88.8
1904	Feb.	18	88	49.7	88.8
1904	Mar.	22	84	49.2	95.5
Averages				49.9	91.2
MINNESOTA AND IOWA DIVISION.					
1903	Dec.	92	70	24.0	23.9
1904	Jan.	62	66	23.9	25.8
1904	Feb.	38	64	20.5	34.2
1904	Mar.	38	64	24.1	23.7
Averages				23.1	26.9

BLUE HEAT IN BOILER PLATES.

Every boilermaker and apprentice who is not posted on the fatal blue heat should at once become familiar with this subject through an actual test, which can be made in the following manner:

Take a piece of steel about 2 ins. wide and about 24 or 30 ins. long, any thickness from say ¼ to ⅝ in. Grind the surface on the emery wheel or grindstone until it becomes bright for a distance of about 10 or 12 ins. on one end, so that you can observe the color when it makes its appearance. Then take it to the blacksmith or flange fire and hold it on top of a clean fire, thus preventing it from becoming smoked up so badly that you cannot see the color. Now move the piece slowly back and forth over the fire and watch it closely until the blue color appears, which will be about the same as is used for tempering a flat chisel for boiler shop use. Then take the piece to the anvil and bend it over double without breaking it if you can. You will find that it will break every time. Take the other end of the same piece, which is perfectly cold, and you can bend it over double without breaking. (The higher the tensile strength the quicker it will break. Soft firebox steel will not break so readily.) This experiment will prove to your satisfaction why many corners have been cracked by heating them just hot enough to produce a blue heat, as the steel will stand far more abuse perfectly cold than it will at a fatal blue heat. If you are working up steel and you see the blue color coming into the steel, stop at once and apply more heat or you may wish you had taken the advice herein given. At a very small cost a little crude oil or gasoline heater can be made and in less than five minutes very heavy material can be made white hot and worked up without any danger of cracking the plates.

Nearly every boilermaker who has followed our advice and made the necessary experiment to familiarize himself with the fatal blue heat will insist on having some sort of a heater in the shop for doing his work properly or he will have sense enough to tell the proprietor that he will not be responsible for the cracking of plates which are heated by placing chunks of red-hot iron on the place to be worked up. This method never heats a plate hot enough to insure working it without danger of cracking, but by using crude oil or gasoline you will never have a break if you stop pounding in time and apply the heat again. It requires but a few minutes to make it white hot again and all danger is thereby avoided.—*Motive Power.*

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R. M. VAN ARSDALE.

J. S. BONSALL, Business Manager.

W. C. TYLER, Manager Eastern Dept

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G. M. BASFORD, Editor.

R. V. WRIGHT, Associate Editor.

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EDITORIAL ANNOUNCEMENTS.

Advertisements.—*Nothing will be inserted in this journal for pay,* EXCEPT IN THE ADVERTISING PAGES. *The reading pages will contain only such matter as we consider of interest to our readers.*

Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

To Subscribers.—*The* AMERICAN ENGINEER AND RAILROAD JOURNAL *is mailed regularly to every subscriber each month. Any subscriber who fails to receive his paper ought at once to notify the postmaster at the office of delivery, and in case the paper is not then obtained this office should be notified, so that the missing paper may be supplied.* **When a subscriber changes his address** *he ought to notify this office at once, so that the paper may be sent to the proper destination.*

ECONOMICAL TRAIN OPERATION.

An important study of train operation has been undertaken for this journal by Mr. George R. Henderson, and will be presented in several articles beginning in the October number.

The letters from railroad officials on the subject of overloading locomotives which appeared in the June number indicate that the operation of locomotives from what may be termed a commercial standpoint has not been studied, and the purpose of the articles is to indicate the need of establishing a method of analysis of the effect of train loads and speeds upon the economy of operation. The question is, What is the efficient way to load locomotives? It is not treated by Mr. Henderson as merely an engineering problem, but he has applied engineering methods to the solution of a commercial problem involving questions which include motive power and operating factors in an effort to deduce the most effective way of obtaining the greatest returns for the money invested.

It has been common practice in times of heavy business to reduce loads in order to increase the total movement of traffic, and it is desirable to know the speeds and loads which are most efficient under ordinary conditions. This includes such items as fuel and water consumption, engine repairs and wages of engine and train crews, not only in absolute quantities, but as affected by such influences as grades, speeds and loads.

It is apparent at the outset that no fixed rules can be laid down for handling traffic on any and every division, but each piece of road may be studied with reference to its conditions of traffic and its physical characteristics. These articles will define very clearly how such a study may be made for any conditions and will enable railroad officers to make the proper analysis of their conditions so that they may apply the suggestions to their own circumstances in order to conduct transportation economically.

Nothing like this has ever appeared in print and Mr. Henderson's articles promise to be exceedingly valuable.

THE FIRST LAW OF PIECEWORK.

The statements on the subject of piecework, made by Mr. Le Grand Parish, in this issue, are based upon successful experience under specially difficult conditions, and those who are working in this direction will find his suggestions helpful.

One thing stands out prominently in the experience of all who are successful in applying piecework, and this is the most important single item in the article—"The first law of piecework is honesty." Piecework is not safe in the hands of a shrewd schemer, a "sharper" or a man who is after a quickly made "record." Neither is it safe in the hands of one who will put it into effect with the issue of a bulletin notice. The time is past when any but a careful, well prepared and well understood plan will answer. The men must have absolute confidence in the system and in the officials who administer it. With this as a foundation the system must be built up as any business is built up, by carefully studying the conditions and developing a plan to fit them. Honesty of purpose will not alone suffice. The men must be provided with facilities, with material, with suitable conditions for working, and they must be aided by the foremen. All this must be done in such a way as to increase as far as possible the earnings of the men, and the men should understand that piecework is a form of commission on output paid in terms of work actually accomplished. Intensity of output is what the railroad wants. One of them gets it to-day with 150 men at one point where 450 men were employed on less work by the day work plan two years ago. The workers, unskilled laborers, receive double their former wages and the company gains an advantage in increased productivity of its plant, in reduced loss of time of its rolling equipment in the shops and in actually reduced cost of the work itself. The secret is "High wages for increased production."

There is nothing in the whole shop administration problem more promising to both employer and employee than piecework. There is also nothing more thoroughly misunderstood by some people. The writer is told by a piecework expert that in a single month he received formal requests for his schedules from seven different railroads. These were properly promptly refused. It is not likely that anyone asking off-hand for a schedule in order that he may introduce piecework will be careful to consider, for example, the nine bases for comparison of piecework prices stated by Mr. Parish.

Mr. Parish does not state the second law of piecework. If he did he would probably express it somewhat as follows: "Place the problem in the hands of the right man and give him the requisite authority and support."

Such men are greatly needed just now. Some railroads are developing them and some are not. Railroad officers may see how rapid has been the development of such experts in industrial fields. The real question after all is to find the men who can administer piecework and educate both management and men in its principles.

HIGH SPEED TOOL STEEL IN RAILROAD SHOPS.

If busy railroad officers who are at their "wits end" to know how to meet the conditions of decreased rates per ton mile and increased cost of labor and material will carefully ponder the record presented by Mr. Jacobs in this issue, they will discover one of the roads they need to follow, that of the application of commercial principles to railroad service.

Mr. Jacobs treats of shop practice, and when "16 to 1," the familiar slogan, is applied so successfully to the improvement of shop tool output, the record is entitled to keen attention by the highest officials of all our railroads. The Union Pacific has become a leader in this movement toward improved shop methods. On cast iron the improvement in output has been

120 per cent.; on steel 150 per cent., and on wrought iron, 175 per cent., considering actual results and the weight of metal removed in a given time. Union Pacific practice, before the new methods were applied, was probably neither far better nor far worse than that of other roads. It is, therefore, safe to say that other roads present the same opportunities for improvement. If the statements of Mr. Jacobs receive the attention they merit, a wave of improvement of machine and shop output will pass over the entire country, and this will mean much for the railroads and for the men into whose hands this opportunity falls.

Nearly every shop has the new tool steels, and blue chips are commonly seen. This, however, is not sufficient. Machine tools, men, and shop methods require a new kind of attention. In fact, the new steels have revolutionized shop practice all over the world, and the railroads have every reason to become leaders in meeting the changed conditions. If these conditions are met, and if the efforts of machine tool builders to supply suitable special machinery for railroads are suitably encouraged, the railroad mechanical officer will be in position to contribute, as he never has before, to the advancement of transportation, and he will take a high place among the leaders of the times. This officer is ready and willing to undertake his task. The main question lies before the management, the directors and the owners. Shall this opportunity be accepted? It will be accepted, and this journal expected to be kept busy recording the steps in this revolution.

FACTS WANTED CONCERNING TREATED WATER.

Arguments which will enable mechanical officials of railroads to secure from their superiors appropriations for improving the feed water of locomotives are largely sought for. A correspondent in a recent communication said:

"I am greatly interested to read the article by Mr. Landon, chemist of the Erie Railroad, which you published in the August number of the American Engineer. You cannot present a more important subject than that of 'bad water' for locomotive use. I wish you would secure more articles of this sort giving convincing figures in such a simple way as to make clear to everyone the necessity for dealing with the water problem in a business-like way. Such arguments will help us all in putting this question in the proper light before our general managers. Of course the expense of constructing treating plants looks large, but we should all engage in an additional effort to show that such investments will pay."

This journal will gladly print good arguments of this sort and facts with figures showing the beneficial results actually obtained from treated water will be specially valuable. Those who are using treated water should be able to state their experience and nothing would be more helpful in this educational process than reports of results actually accomplished.

Interesting figures for the performance of the De Glehn compound locomotives are noted in the communication by Mr. Edward L. Coster in this issue. With 1,900 h.p. as a basis, Mr. Coster shows that the locomotive illustrated in the June number of this journal, which is the same as the De Glehn compound on the Pennsylvania, developed one I. H. P. for each 1.38 sq. ft. of total heating surface; 0.73 I. H. P. per square foot of heating surface, and 23.7 I. H. P. per net ton of total weight of locomotive. This indicates that the boiler of this locomotive is exceedingly effective. It is not easy to draw a fair comparison with an American locomotive, but the best performance up to date with a certain exceedingly powerful American engine (not known to be the limit of capacity of that engine) shows a production of one I. H. P. for each 1.74 sq. ft. of total heating surface; 0.57 I. H. P. per square foot of heating surface, and 19.8 I. H. P. per net ton of locomotive. A comparison of these figures, while not conclusive, indicates the advantage in efficiency of the best possible use of the weight of locomotives. The De Glehn compounds are believed to be far in advance of American practice in this respect. It is worth while for American locomotive designers to make a most careful study of Mr. De Glehn's designs.

CORRESPONDENCE.

ADJUSTED TONNAGE RATINGS.

To the Editor:

In the July number, Mr. Vaughan suggests the general application of my formula for adjusted tonnage ratings by simply varying the coefficients in order to fit approximately with the results of various experiments, which can very easily be done. I notice, however, what is apparently a misprint. At the top of page 255 the allowance for grade is given as 2g, in the formula $R=(3+2g)W+100C$, g representing the per cent. of grade. This evidently should be 20g, as the resistance on a 1 per cent. grade is 20 pounds per ton.

Mr. Vaughan thinks the chart is unnecessary, but the object is to avoid all need for calculations, as some freight trainmen are not over handy with a pencil, and the chart obviates this difficulty.

G. R. Henderson.

SUGGESTIONS BY A SPECIAL APPRENTICE.

To the Editor:

It was with considerable interest that I read the paper, by Mr. R. D. Smith, on the Special Apprentice, in your July number. However, as a special apprentice I cannot agree with the suggested changes in the special apprentice course. True, the courses offered by many railroads show room for improvement, but I believe the division of the course into three more highly specialized courses would be a step in the wrong direction.

To consider this subject fairly it might be well to decide what is the ultimate aim of the special apprentice. After a man has spent four years and considerable money, and has safely weathered a technical course at one of the leading universities, and has then put in four more years at the low wages offered the special apprentice—it seems to me that a "special" would not be worthy of the name if he did not cherish the ambition of ultimately attaining a higher position than that of a shop foreman. Now, to successfully hold such positions as chief draughtsman, engineer of tests, mechanical engineer, master mechanic, superintendent of motive power, etc., would it not be better to have a general knowledge of locomotive work, car building, and road work, and not to be a specialist in any one of these branches?

To divide the course up as Mr. Smith suggests would perhaps better fit a man to become a shop foreman, but even this might be questioned. In any one of the three suggested courses, you will find the same difficulty as is claimed to exist in the present course, namely: A man does not spend a sufficient time in any one shop to take charge of that shop. By similar reasoning to make a successful shop foreman a special should confine his course to four years in one shop. Such a process would, however, kill the special apprentice course as the technical graduates would all choose the manufacturing industries, where a competent man can readily obtain $60 to $75 a month at the start, which is as much, and in many cases more, than the special apprentice receives in the last six months of a four-year course.

To hold up a position as a shop foreman as the ultimate aim of the special would cause a man to think long and hard before entering railway service, when he can reasonably expect if he shows ability (which is necessary in either case) to be drawing $125 to $150 a month several years before he could become a shop foreman at $100 a month.

The ability to handle men would not be acquired any more readily in a more highly specialized course. A master mechanic may be better able to deal with machinists if he has worked up from a machinist. But, does it follow that he would also be better able to handle car builders and road men because he served his time as a machinist? Would not a course which includes contact with men in all three branches better fit a master mechanic to successfully handle his men?

True, the special apprentice courses as mapped out by many roads could be bettered. As a special I would suggest the following for a four-year course: Locomotive erecting shop, 9 months; roundhouse helper, 6 months; firing, 3 months; coach erecting shop, 6 months; freight car repair track, 3 months; office work with chief clerk, 3 months; laboratory and test work, 6 months; draughting room, 6 months. The last six months could very profitably be spent, as Mr. Smith suggests, along such lines as the master mechanic may intend to promote the special on the completion of his course. As an example, if it is intended to start him as a roundhouse foreman at some small division point, then the last six months should be devoted to general roundhouse work.

In the course that I have mapped out you will undoubtedly notice

that I have entirely omitted the customary machine shop, foundry and pattern shop included in most courses. With a basis of the shop work taken in his technical course at the university, I believe that a wide awake special can easily acquire a good working knowledge of these branches while in the other courses, which are essentially all erecting.

In the coach shop and on the repair track a man can by keeping his eyes open get a good general knowledge of the car machine, wood machine, blacksmith and cabinet shops. Likewise, while in the locomotive erecting shop and roundhouse, a man can get the general run of the locomotive, blacksmith, machine, boiler and tank shops. Three months of pool firing together with the roundhouse work should be sufficient to give a man a fairly good idea of road work.

Mr. Smith comes very close to the mark when he says that the railroad company owe it both to themselves and the special to either drop him entirely when he has completed his course or to place him in some responsible position at a reasonable salary. It certainly is not right to keep a man hanging on at his rate of special apprentice pay to do all the emergency jobs that turn up. If the company need a man for such work, then let them pay at least a first-class mechanic's wage. If a man is not worth $90 or $100 a month to the company, after finishing his course, then by all means discharge him. If he is a competent man he can readily find employment outside of the railway service at $100 to $125 a month. The railway supply companies offer a very inviting field and do not hesitate to take a good special, even before he has finished his course.

A SPECIAL APPRENTICE.

SPECIAL APPRENTICESHIP.

To the Editor:

When the subject of special apprenticeship is sufficiently ventilated something may perhaps be done to render railroad work a suitable field for the college man. At present railroads are conducted in such a way as to completely discourage young men to fit themselves by education to fill positions of responsibility. The paper by Mr. R. D. Smith, printed in your July number, indicates that, at least, one official appreciates the fact that something is wrong

My point of view is that of a man who spent five years in railroad service, after four years at college and had to leave the road in order to secure a salary on which a self-respecting young man could live, and yet at once went to a position with a manufacturing concern where he received proper compensation. I liked railroad work better than anything else, but could not afford to wait for ordinary recognition.

Very little is gained by talking about special apprenticeship, simply because the railroads are not ready for apprentices of any kind. The trouble is deep seated and the motive power departments are wrongly organized or not organized at all. My unsatisfactory experience was due to the fact that the master mechanic under whom I worked was so loaded down with details and had so little adequate assistance of any kind that he could not possibly attend to so small a matter as the cultivation of a knowledge of his subordinates. If such papers as yours would give less space to corners of machine shops and what is put in them, and more space to the fundamental principles of department organization there would be little need for saying anything about special apprenticeship. The trouble lies not with the college men, but with officials who do not know how to use them properly. Many an official holds his position to-day because he has college men about him to help him out of the holes he gets into, because of being merely a "practical" man, and yet they are unable to see that college men may be trusted with responsible positions where technical education is a necessary qualification. They do not have time to study and develop the possibilities of the college graduate.

The real trouble lies in the fact that the motive power departments are not run on a business basis and the officials are not clothed with sufficient authority to operate their departments in such a way as to develop men. And this is why mechanical practices of the most obsolete forms are prevalent in railroad shops. Little encouragement is offered for young men to develop themselves. I do not believe this to be the fault of the mechanical officials, but of the managements for treating the mechanical departments in a way which utterly discourages efforts to advance because patience is worn out by utter disregard of those efforts. The worst feature of the matter is that the officials with whom I have come in contact were themselves discouraged. The remedy lies in reorganizing the department and placing the head of it in a position of importance. He should report to no one short of the president. If this is done there will be an end to the whole special apprentice "problem."

A. B. C.

EDITOR'S NOTE.—This young man now occupies an important position in charge of about 1,000 men. He has advanced rapidly because of his ability to manage men and it is a pity that he should be lost to railroad service where such ability is so greatly needed.

He presents a warm "roast" of the mechanical department and he seems to have a clear title to his plainly expressed opinions.

PERFORMANCE OF A DE GLEHN COMPOUND LOCOMOTIVE—PARIS-ORLEANS RAILWAY.

To the Editor:

In the course of the extremely interesting article upon the De Glehn compound Atlantic type express locomotives of the Paris-Orleans Railway, which appeared on page 203 of the AMERICAN ENGINEER for June last, the following statements occur: "Word has just been received that one of the Paris-Orleans engines, which is exactly like the one illustrated, has just indicated 1,900 h.p. at 70 miles per hour, with 350 tons behind the tender, the drawbar pull at that speed being 7,350 lbs. It must be remembered that this engine weighs only 80 tons." Let us consider what these figures signify, and the conclusions which may be derived therefrom.

In the table of general dimensions accompanying the article above mentioned, the total heating surface of this locomotive is given as 2,616.8 sq. ft.; hence the foregoing performance is equivalent to the development of one indicated horse-power for each 1.38 sq. ft. of heating surface; or 0.73 indicated horse-power per sq. ft. of heating area.

It is also equal to the production of one indicated horse-power for each 84.2 lbs. total weight, or 23.75 indicated horse-power per net ton.

The drawbar stress (presumably at the rear coupler of the tender) being 7,350 lbs., and the velocity 70 miles an hour, the net drawbar horse-power is 1,372, or 72.2 per cent. of the indicated horse-power. Hence, assuming these results to have been attained on level track, the locomotive developed one effective drawbar horse-power for each 1.91 sq. ft. of heating surface, or 0.52 drawbar horse-power per square foot of heating area. This equals the production of one drawbar horse-power for each 116.6 lbs. total weight, or 17.15 drawbar horse-power per net ton. Consequently, we obtain the following relations between power, heating surface, and total weight:

Indicated horse-power = 0.73 (heating surface in sq. ft.).
Indicated horse-power = 23.75 (total weight in tons).
Drawbar horse-power = 0.52 (heating surface in sq. ft.).
Drawbar horse-power = 17.15 (total weight in tons).

Making due allowance for the superiority of the fuel used upon French railways as compared with that usually employed in this country, together with the probability that 1,900 indicated horse-power was sustained but for a comparatively short time, do any records exist showing equal efficiency for an 80-ton American locomotive?

Assuming level track, then, at 70 miles per hour, 1,900 — 1,372 = 528 h.p. were consumed in overcoming the machinery friction, and the rolling, axle, and atmospheric resistances of the locomotive and tender, weighing 146.25 tons in working order; or

$$\frac{528}{146.25} = 3.6 \text{ h.p. per net ton, equivalent to a total resistance of}$$

$$\frac{3.6 \times 375}{70} = 19.3 \text{ lbs. per ton.}$$

The significance of this small loss of energy between the cylinders and the tender coupler will be apparent when it is recalled that during the discussion of M. Edouard Sauvage's paper, "Compound Locomotives in France," at the April, 1904, meeting of the Institution of Mechanical Engineers, Mr. Sisterson, who had charge of the tests made upon the London & Southwestern Railway for the purpose of ascertaining the power necessary to drive light locomotives at various speeds, presented a table showing that in the case of Mr. Dugald Drummond's 4-4-0 type, single-expansion express locomotive No. 706, which has 18½-in. x 26-in. cylinders, driving-wheels 77⅝ ins. in diameter, and weighs with its tender about 100.8

American tons, 912 indicated horse-power were required to propel the engine and tender alone at a velocity of 70 miles an hour; or, approximately $\frac{912}{100.8} = 9.05$ h.p. per net ton, equal to a total resistance of $\frac{9.05 \times 375}{70} = 48.5$ lbs. per ton. Although, as Mr. Sisterson explained, the reliability of these trials was impaired by the unsuitable nature of the road upon which they were made, the locomotive having been started on a slight descending grade and run round a curve on to a level tangent, the results are nevertheless instructive as indicating in a general way the relative resistance at the same speed (70 miles per hour) of the Paris-Orleans and London & South-Western locomotives, which resistance appears to be about in the ratio of 3.6 to 9.05 h.p. per ton of locomotive and tender, respectively, or 19.3 to 48.5 lbs. per ton.

Now, in a certain experiment it was found that, other conditions remaining constant, the employment of an aluminum piston in a motor car engine resulted in an increase in speed of 300 r. p. m., as compared with the maximum possible when a heavier material was used. This fact, while demonstrating the great influence which the weight of the reciprocating parts of an engine exert upon its rotational speed, also apparently disproves the commonly accepted theory that according to the doctrine of the conservation of energy, the energy expended by the steam in accelerating the reciprocating masses during the first half of their travel is restored to the crankpin by the inertia of these parts during the latter half of the stroke.

These considerations suggest the hypothesis that the freedom of running of the De Glehn compound locomotive, and the high ratio of the drawbar to the indicated horse-power (72.2 per cent. in the above example), is largely due to the inherent characteristics of the design whereby, owing to the subdivision of the total work between four crankpins and the consequent reduction in weight of the individual reciprocating parts, together with the almost perfect balancing of the inertia forces developed by the latter, the loss of energy caused by reciprocation is considerably less than in an ordinary two-crank locomotive of equal power. From the experiment with the aluminum piston it appears certain that the acceleration of the reciprocating parts of an engine results in a great loss of energy, but, so far as I am aware, the precise cause of this loss is at present unknown.

Whether it be due to friction, to heat interchange between the steam and the cylinder walls, or to other influences, is for the moment quite immaterial; the important practical fact is that for maximum efficiency the individual reciprocating masses of high-speed engines should be as light and their inertia effects as completely neutralized as possible; both of which ends are attained in the four-cylinder balanced type of compound locomotive.

EDWARD L. COSTER,
Assoc. Am. Soc. M. E.

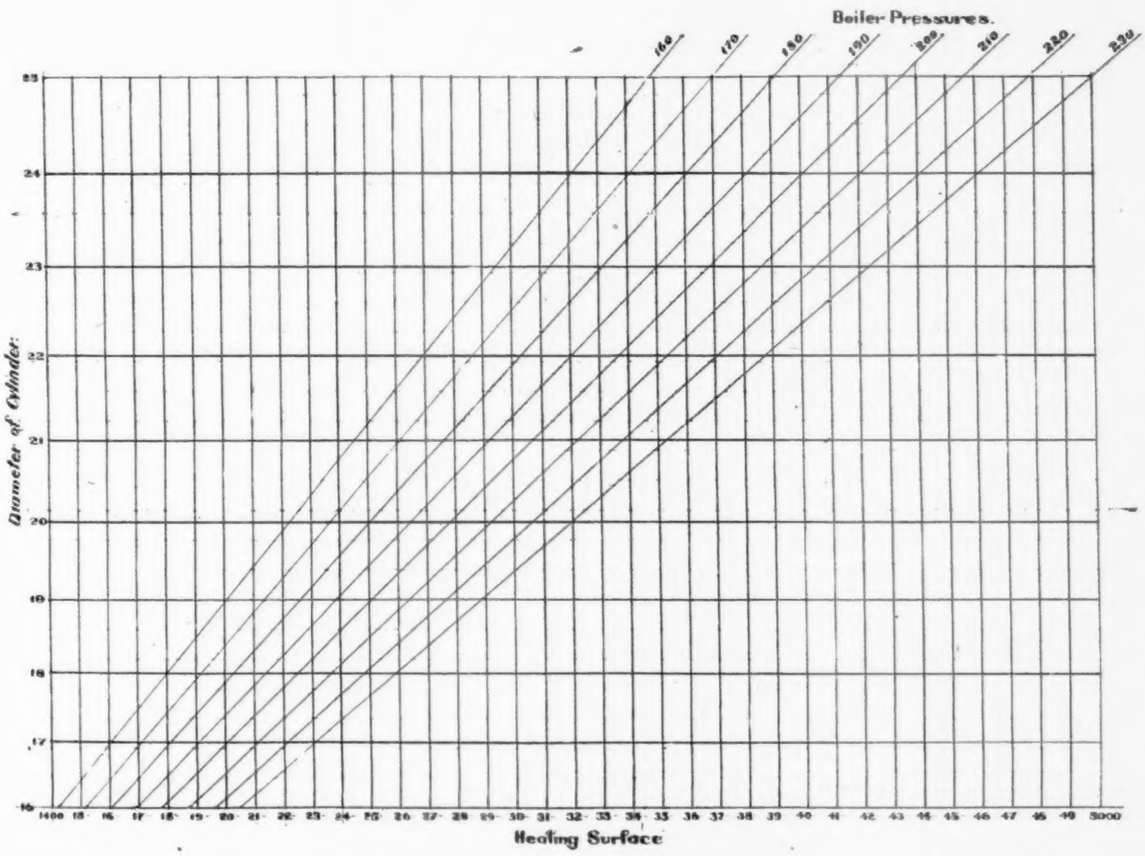
25 Broad street, New York,
August 13, 1904.

STEAMING CAPACITY OF LOCOMOTIVES.

To the Editor:

The article by Mr. Bentley on steaming capacity of locomotives, published in your issue of July, 1904, has been of much interest to me, especially so far as it pertains to simple engines. The equations given for horse power and maximum horse power and heating surface are useful as well as interesting. I should like, however, to make a few comments on one diagram as printed in connection with the article. In the diagram for heating surface for simple engines the correct figures can only be obtained for an engine having cylinders 25 ins. in diameter, and even if the intersections of the boiler pressure lines on the 16-in. cylinder line had been correctly made, it would still be possible only to obtain a correct heating surface for the 16-in. and 25-in. engines. To make the readings correct for other sizes of cylinders the ordinates of the diagram should vary directly as the square of the diameters, rather than as the diameters of the cylinders. I submit herewith a rough sketch of this diagram, which I think is more nearly correct.

HARRY S. BURNHAM, Chief Draughtsman.
D., M. & N. Ry., Proctor, Minn.



STEAMING CAPACITY OF SIMPLE LOCOMOTIVE.

LOCOMOTIVE FLUE SETTING AND MAINTENANCE.

To the Editor:

In his professional conventions the master mechanic and the master boiler maker give the subject of locomotive flue setting a share of their thoughtful consideration, and much of value to the well being of the locomotive boiler has resulted. When the railroad officer returns to his own road he gives some attention in a general way—spasmodically, perhaps, in some instances—to the care of flues and boilers in service, but in the writer's opinion the

subject is not receiving the attention and persistent following up which its direct relation to successful engine performance entitles it.

To be a money-making machine for a railroad company a locomotive must be able to take its rating over the road without failure. In bad water districts the pre-eminent cause of engine failures is leaky flues. So directly does the leaky flue affect the earning power of a railroad company that the writer feels warranted in presenting in some detail this seemingly well worn subject.

The three principal conditions upon which satisfactory service of flues is dependent are:

(a) Proper methods in setting flues; (b) effective safeguards against too sudden and unequal expansion in boiler and flues, and (c) keeping the boiler and flues as free as possible from incrustation and accumulation of loose scale and mud.

It is to the first of these that attention will be chiefly directed. There have been times, perhaps, in the experience of every one having to do with locomotive flues when they would leak in spite of anything that could be done. The methods suggested in this article are not advanced as new discoveries, or as cures for all flue troubles, but they represent practice which service has demonstrated will meet the conditions imposed by bad water in the limestone territory of the Middle West as well as any known methods. The recommended method of flue setting is here presented in tabular form:

TABULAR STATEMENT OF FLUE SETTING METHOD.

BACK END.

OPERATION.	TOOL USED.
Expand Copper Ferrules	Prosser Expander
Drive in Flues	Sledge and pin with collar
Mandrel (lightly)	Taper mandrel pin
Roll	Dudgeon roller by hand
Expand	Prosser expander
Bead and Caulk	Beading tool in air hammer

FRONT END.

OPERATION.	TOOL USED.
Shim with Sheet-iron Strips	
Roll	Dudgeon roller by air
Mandrel	Taper mandrel pin

Each step in the process will be commented upon and reference made to the accompanying illustrations.

Flue Sheet Holes. (Fig. 1.)—Care should be taken that holes in flue sheet be true, smooth and free from burrs and sharp edges. It is desirable that the flue hole have a fillet, especially on the water side, of about 1-32 in. radius. A sharp edge around the hole often cuts the ferrule in two, even cutting into the flue. The diameter of the flue hole should be the same as the outside diameter of the flue.

The Copper Ferrule (Fig. 2.)—For new work this should be not far different from No. 16 B. W. G. In old flue sheets when the flue holes are large it is advisable to use enough heavier ferrules to bring the internal diameter of ferrule when expanded into flue sheet to 1⅞ ins. for a 2-in. flue. The object of the copper ferrule is to provide a yielding medium against which to work the flue and make it tight. Its function is analogous to that of a gasket in a pipe union or the rubber ring in the top of a glass preserve jar. The ferrule should be set into the flue hole flush with the fire side and expanded into place with Prosser expander. (Fig. 3.) To perform its full usefulness, a ferrule should be not less than ¾ in. long; ¾ in. is sufficient, although some authorities prefer ⅞ in. The flue, or safe end, should be No. 10 or No. 11 B. W. G. When flues require frequent working the No. 10 gauge is preferable, having more substance to resist wear and tear. The 2-in. flue should be swaged down to 1⅞ ins. Great care should be taken to give the swage the right length and to have it terminate (Fig. 4) in as abrupt a shoulder as possible. The flue after it is swaged should be annealed and the scale removed from the portion entering the sheet. Grinding this scale off by machine is desirable, but in the absence of a grinder the removal of the scale with a file will answer. The flue when driven into the sheet (Fig. 5) should extend 3-16 in. through the sheet on the fire side.

Mandrelling out the flues in the back flue sheet is the next step (Fig. 6). This is done with a tapered steel pin for the double purpose of securing the flue into the sheet preparatory to rolling and for starting the flue tip flaring out, the first step in the turning of the bead.

Rolling.—The front end of the flues having been shimmed with strips of sheet iron, both the back and front ends are rolled with the Dudgeon roller. With proper appliances the front end may be safely and economically rolled by air. The rolling of the back ends is another matter; these should be rolled by hand, as there is too much at stake to risk the danger of damaging the flues by improper rolling. There is not the safety and uniformity of work in air rolling that obtains in hand rolling by a competent workman.

Expanding (Fig. 7.)—Particular stress should be placed upon this, the most important step in the flue setting process. It is a mistake to regard the bead as the part requiring the most attention. The portion of the flue next to the sheet on the water side is as important as the bead. Care should be taken that the flue shoulder when heavily expanded bears snugly and firmly against the flue sheet. This part of the work, if thoroughly done, will contribute much to making the flue permanently tighter. With proper shape of Prosser expander sections, the projecting portion of the embryo bead can be further turned.

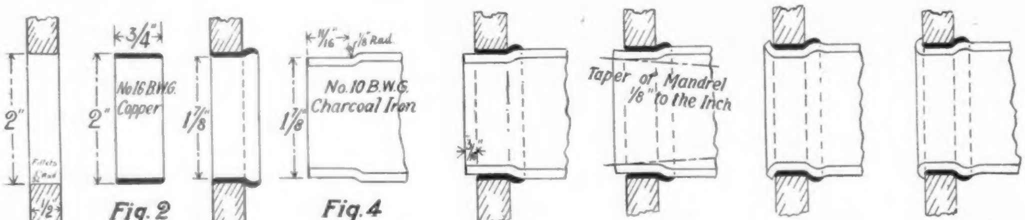


Fig. 1 The Flue Sheet Hole. *Fig. 2* The Flue Ferrule. *Fig. 3* Ferrule Expanded into Flue Sheet with Prosser Expander. *Fig. 4* Swaged End of Flue. *Fig. 5* Flue Driven into Sheet. *Fig. 6* Flue Mandrelled out Lightly. *Fig. 7* Flue Expanded. *Fig. 8* Flue Beaded and Finished.

Beading (Fig. 8.)—This may now be done with a beading tool in an air hammer, which, with mandrelling the front end, finishes the flue setting.

On the care and maintenance of flues in service much could profitably be said, but it is impracticable to add more than the following hints in conclusion:

Prevent the extravagant use of the blower, especially when cleaning fires or when grates are partly uncovered. Insist upon the gradual cooling down of a boiler before washing out or changing water. Maintain as near 100 lbs. washout water pressure as possible. Depend chiefly on the caulking tool and Prosser expander to keep flues tight. The mandrel pin may be used with discretion, but the use of the Dudgeon roller in the roundhouse should be practically unknown.

L. L. SMITH.

STAYBOLTS.

To the Editor:

The recent increase in the number of articles in current magazines on the subject of staybolts has attracted my attention with unusual interest. Doubtless this much discussed subject, "The cancer of the locomotive," will be fresh in our minds till some genius designs a watertube boiler applicable to the modern locomotive.

The suggestions in the AMERICAN ENGINEER for August, 1904, page 311, relative to decreasing the diameter and increasing the length of the staybolts seems to me to be a step in the right direction. The factors to be taken into consideration are three in number, viz.: (1) Direct tensile strength; (2) tensile strength at temperatures corresponding to boiler pressure, and (3) stress caused by bending.

For tensile stress only, the area to be supported is easily proportioned to the size and strength of the bolt. The tensile strength and percentage of elongation, or, in other words, elasticity, increase with the temperature, as is shown by the diagrams in the AMERICAN ENGINEER for July, 1904, page 253; so there is no fear from this source with pressures up to 400 lbs. I do not think the "blue heat" temperature spoken of in this article is "fatal" with modern staybolt iron.

The relation to bolt proportions of stresses caused by bending is shown by the ordinary formula for a cantilever and the change in stress caused by varying the diameter, or length, with a constant deflection, is shown as follows:

Suppose the bolt to be fixed in the outer sheet and the inner end free—

Let d = deflection of the firebox end.
D = dia. at root of thread.
l = length of bolt between sheets.
p = fibre stress due to bending.
E = modulus of elasticity.
e = distance of outer fibre from neutral axis.
P = deflecting force at firebox end.
I = moment of inertia of section at point of max. moment.

Then,

$$d = \frac{Pl^3}{3EI} \quad (1), \quad Pl = \frac{pI}{e} \quad (2), \quad d = \frac{pl^2}{3Ee} \quad (3).$$

If we wish to find the effect on p of varying l only, reduce formula (3) to the form $(3deE)\frac{1}{p} = l^2$ (4) where d, e, and E are constant.

This shows that the fibre stress in the bolt next to the outer sheet decreases with the square of the increase in length. Therefore the longer the bolt the less will be the stress due to bending; the deflection of the inner end being the same for all lengths.

To find the effect of varying the diameter with a constant length, reduce formula (3) to the form: $\frac{3dE}{2l^2} D = p$, $(D = 2e)$, (5).

Here d, E and l are constant and p varies directly with the diameter, or, in other words, the larger the bolt the greater the stress. Therefore make the bolt as small as possible, consistent with tensile strength.

If with formula No. 3 we use a deflection of .015 in., l = 4 ins., for a nominal 1-in. bolt with 12 threads, we find the stress is carried well beyond the elastic limit of any good iron, and this seems to be a very close limit for deflection.

If the owner of the machine described in the article on page 253 of the July number will make some experiments, using the above formula for plotting curves, with "number of vibrations" in place of p, I think he will find that the longer the bolts of one diameter the greater the number of vibrations, and also the smaller the diameter of the bolt, greater than the minimum limit for tensile strength, the greater will be the number of vibrations.

L. H. SCHENCK.

CUTTING TEST ON METAL PLANER.

BY J. C. STEEN.

The cutting test here described was made during the regular progress of the work through the shop. The material was cast iron and the casting weighed 3,000 lbs.

The dimensions of the cuts were so regulated as to bring depth and thickness into measurable quantities, and a number of cuts were made to determine the effect of the form of cut upon the power required. This feature of the test was not altogether satisfactory, as the power required to run the planer light varied somewhat, and a small error is easily made when taking ammeter readings, particularly with a fluctuating current due to a varying load. Whatever the causes were, the results are somewhat at variance with what might have been expected.

The planer on which the test was made is a 48-in. x 16-ft. machine, which was driven during the test by a Northern Electric Company motor, belted to an auxiliary shaft, which in turn was belted to the planer countershaft.

The table is so arranged that the power required may be seen in relation to either cubic inches of metal removed per minute, or pounds of metal removed per hour. The value of C given in the table relates to the constant C in the formula W × C = H. P., where W is the weight of metal removed per hour. C is a constant varying under different conditions.

thickness of cut is meant the amount of feed. This explanation is made because different expressions are frequently used to denote the same thing.

Cuts 1 and 2 show that a relatively less amount of power was taken for 2 than for 1, and the same is true of 5 and 6, referring, of course, to net power. Cuts 8 and 9 might have been expected to show the least amount of power for a given section, but both are slightly higher than 6, which shows the least of all. A small variation might be allowed for by reason of the variation in the driving power, but probably the condition and shape of the cutting tools, as well as variation in the quality of the metal may account for the results being at variance with what might have been expected.

It will be seen that the average of net power constants for 1 and 2, and 3 and 4 are the same, and that those for 5, 6 and 7, and 8, 9 and 10, are quite close; also that the average constants for the gross power from 3 to 10, inclusive, are about the same.

In this test the results for 11 and 12 indicate that the thin cuts took relatively more power than the heavier ones. These

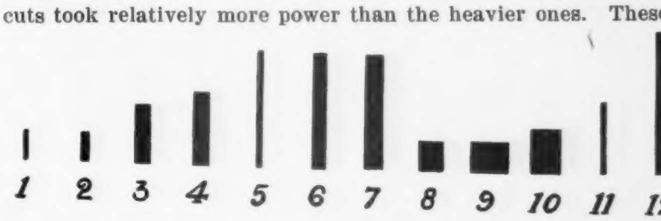


DIAGRAM SHOWING RELATIVE SIZES OF CUTS.

Cut No.	1	2	3	4	5	6	7	8	9	10	11	12
Depth of cut	¼	¼	½	⅝	1	1	1	¼	¼	⅝	⅝	1¼
Thickness of cut	1-32	1-16	⅛	⅛	1-32	3-32	5-32	3-16	5-16	¼	1-32	3-64
Area of cut sq. ins.	.0078	.0156	.0625	.078	.0312	.094	.1562	.047	.078	.094	.0195	.058
Cu. ins. per min.	1.41	2.82	11.25	14.	5.62	16.86	28.1	8.46	14.	16.86	3.51	10.45
Wt. removed per hr.-lbs.	22	44	175	219	88	263	438	132	219	263	55	163
H.p. req'd—gross	5.1	5.4	8.8	9.6	6.6	8.1	11.4	7.3	7.9	9.6	.6	9.6
H.p. req'd—net	.6	.9	4.3	5.1	2.1	3.6	6.9	2.8	3.4	5.1	1.5	5.1
H.p. per cu. in.—gross	3.62	1.91	.78	.68	1.18	.48	.41	.86	.561	.57	1.71	.92
H.p. per cu. in.—net	.42	.32	.38	.36	.37	.214	.24	.33	.24	.302	.43	.49
Value of C—gross h.p.	.23	.122	.05	.042	.076	.0308	.026	.055	.036	.036	.109	.059
Value of C—net h.p.	.027	.020	.024	.023	.024	.0137	.0157	.021	.015	.0194	.027	.031
Av. value C—gr. h.p. (1–2) .176; (3–4) .046; (5–7) .0442; (8–10) .042; (11–12) .084	.176		.046			.0442			.042		.084	
Av. value C—net h.p.	.0235		.0235			.0178			.0184		.029	

The average power required for running the motor, shafts and machine pulleys was 3 h.p. with the platen at rest, and 4.5 h.p. with the platen moving in direction of the cut.

Other tests have shown that when cutting cast iron the quality of the metal and shape of the tool have considerable to do with the power required. Some tests have shown that with a given depth of cut the power required increased almost directly in proportion to the thickness, and in other cases the power required increased at a slightly greater rate than the thickness. Again, it has been found that in some cases the minimum amount of power required to remove a given amount of metal was when the depth and thickness of the cut were equal. By depth of cut is meant the height from the planed surface to the rough face of the casting, and by

results should not be taken as conclusive, but are of interest and value as approximations. It may be explained further that the amounts expressed as cubic inches per minute and pounds per hour are not actual, as the time lost by return of platen was not taken into account, but they represent the rate at which metal would have been removed had the cutting been continuous. To obtain a correct record of actual power cost in relation to metal removed, it would be necessary to weigh all chips, and to use a recording ammeter for the amount of energy used throughout the whole cycle of platen movements. Such figures are not so frequently needed as those which deal with the amount of power required to remove a certain assumed amount of metal and to otherwise operate the machine.

HEAVY PASSENGER LOCOMOTIVE.

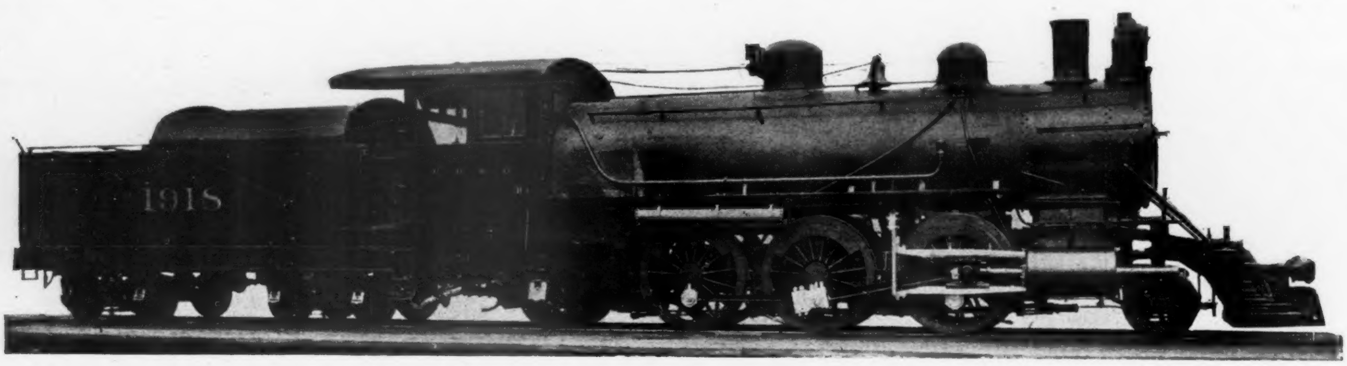
2—6—2 TYPE.

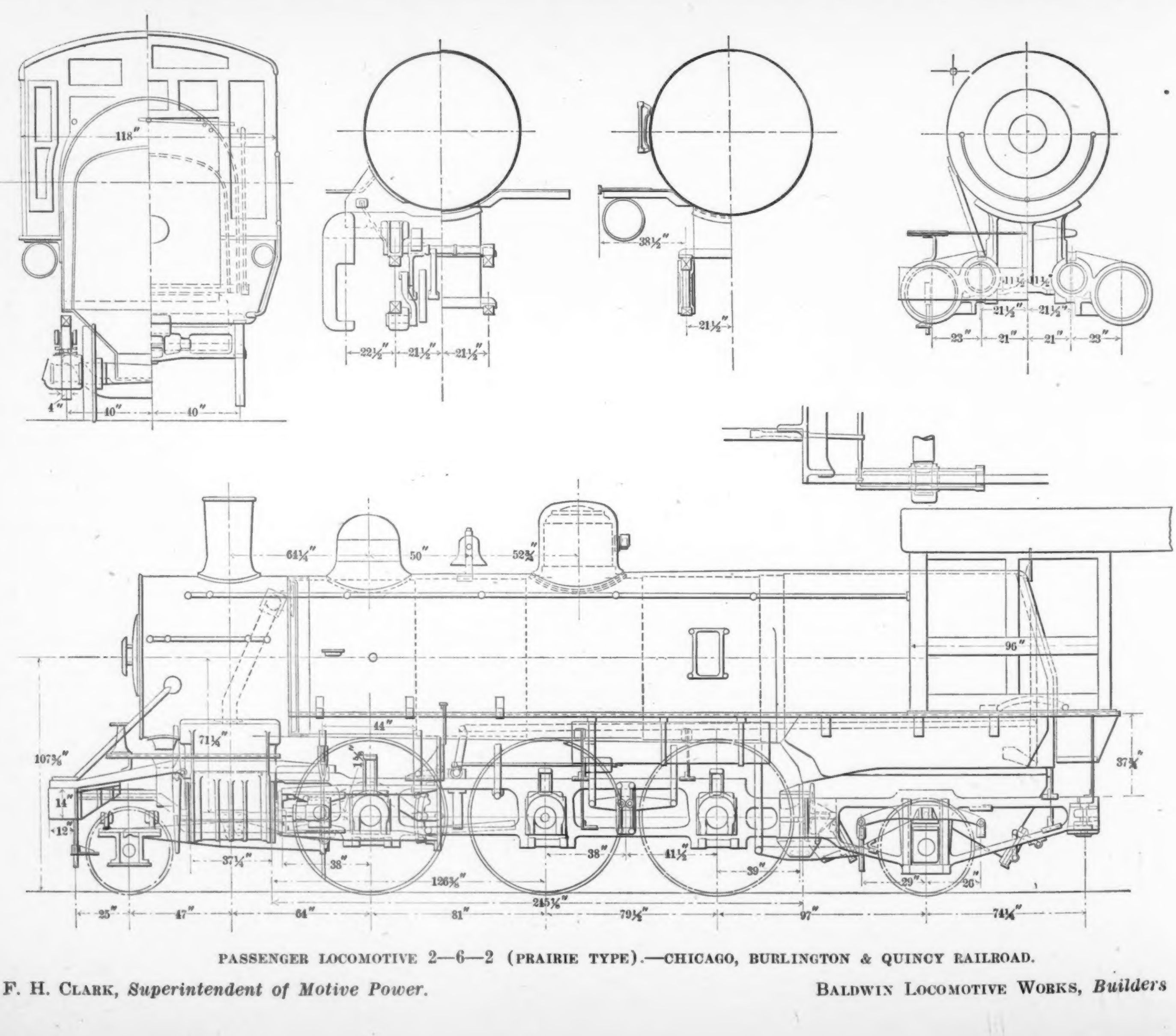
CHICAGO, BURLINGTON & QUINCY RAILWAY.

A new design of Prairie type passenger locomotive has been built for this road by the Baldwin Locomotive Works, and 40 are being put into service. They are single-expansion engines with piston valves and 22-in. by 28-in. cylinders, the tractive effort with 69-in. wheels being 35,000 lbs. These engines have 151,070 lbs. on driving wheels, which is the heaviest weight on 6-coupled wheels in our record. The boiler is straight and has 301 2¼-in. tubes, 19 ft. long, the total heating surface being 3,575 sq. ft. and the grate area 55 sq. ft. This road has had a long and very satisfactory experience with 2-wheel leading trucks, and this construction has not been confined to freight service, but has been followed in the heaviest passenger locomotives with entire success, and on a road which is by no means straight. This is one of the largest and heaviest locomotives of this type in our record, and there seems to be no question of the advantages of the type over the Pacific type with a 4-wheel leading truck. The trailing truck has outside journals and the arrangement for spreading the rear sections of the frames under the firebox, used on several recent Chicago, Burlington & Quincy designs, has been followed in this case. A summary of the leading dimensions of the engine is given in the accompanying table:

CHICAGO, BURLINGTON & QUINCY RAILWAY 2—6—2 TYPE LOCOMOTIVE.

Gauge	4 ft. 8½ ins.
Cylinder	22 ins. x 28 ins.
Valve	Piston
Boiler—Type	Straight
Diameter	70 ins.
Thickness of sheets	¾ ins.





PASSENGER LOCOMOTIVE 2—6—2 (PRAIRIE TYPE).—CHICAGO, BURLINGTON & QUINCY RAILROAD.

F. H. CLARK, *Superintendent of Motive Power.* BALDWIN LOCOMOTIVE WORKS, *Builders*

Working pressure	210 lbs.
Fuel	soft coal
Staying	radial
Firebox—Material	steel
Length	108⅛ ins.
Width	72¼ ins.
Depth	front 72½ ins., back 61⅝ ins.
Thickness of sheets, sides ⅜ in., back ⅜ in., crown ⅜ in., tube ½ in.	
Water space	front 4½ ins., sides 4 ins., back 4 ins.
Tubes—Material	Iron
Wire gauge	No. 11
Number 301	diameter 2¼ ins., length 19 ft. 0 ins.
Heating surface—Firebox	190 sq. ft.
Tubes	3,354 sq. ft.
Firebrick tubes	51 sq. ft.
Total	3,575 sq. ft.
Grate area	55 sq. ft.
Driving wheels—Diameter outside	69 ins.
Diameter of center	62 ins.
Journals	main 9½ ins. x 12 ins
Engine truck wheels (front)	diameter 37¼ ins.
Journals	6 ins. x 10 ins.
Trailing wheels—diameter	42½ ins.
Journals	8 ins. x 12 ins.
Wheel base—Driving	13 ft. 4½ ins.
Rigid	21 ft. 5½ ins.
Total engine	30 ft. 8½ ins.
Total engine and tender	55 ft. 8½ ins.
Weight—On driving wheels	151,070 lbs.
On truck, front	23,260 lbs.
On trailing wheels	34,220 lbs.
Total engine	208,070 lbs.
Total engine and tender	360,000 lbs.
Tank—Capacity	8,000
Tender—Wheels, No. 8	diameter 33 ins.
Journals	5½ ins. x 10 ins.

POWERFUL TURRET LATHE FOR RAILWAY SHOPS.

A 5-in. by 42-in. automatic chuck turret lathe, the most powerful ever built, has just been shipped by Bardons & Oliver, of Cleveland, Ohio, to the new Montreal shops of the Canadian Pacific Railway.

Fig. 1 shows a general view of this machine, which represents a gradual development of their regular line of turret lathes for bar stock, and is especially designed to meet the exacting requirements of the modern shop with its high speed tool steels. Up to this time it has been customary on turret machines taking as large as 5-in. round bars to use a special type of lathe chuck for gripping the stock. The makers of this machine have adhered to a modified form of the standard automatic chuck, believing from their experience that no other method of holding a bar has ever been devised that will equal in gripping power the so-called spring chuck or collet, providing it is properly designed and constructed. In no other form is the stock gripped equally around the entire circumference and the cutting tools brought so near the spindle bearing.

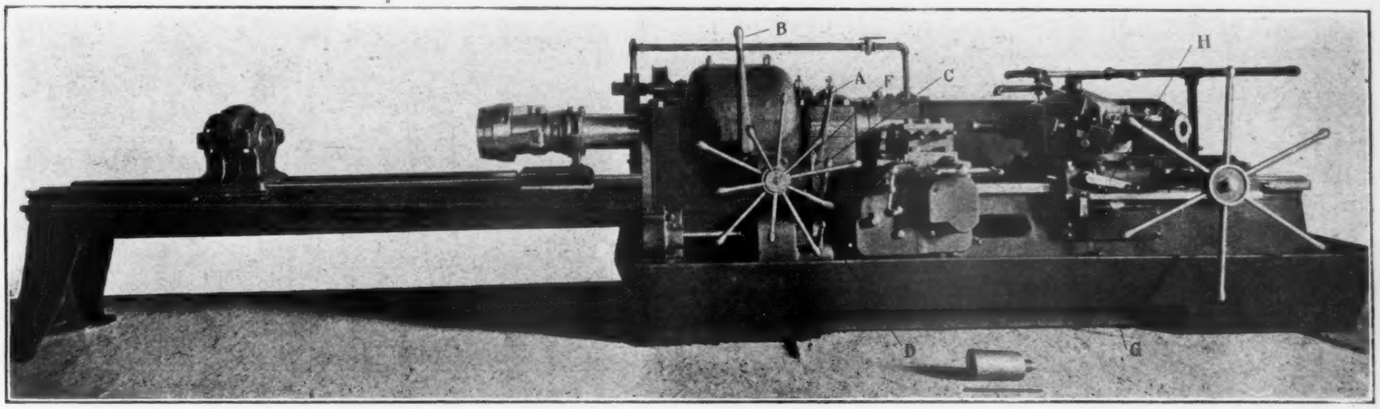


FIG. 1—AUTOMATIC CHUCK TURRET LATHE.—BARDONS & OLIVER.

Another departure from the ordinary practice is in the method of supporting the outer end of the bar. There are two usual methods of doing this, one to place a chuck at the rear end of the spindle, necessitating opening and closing same after each piece is made, and the other to allow the bar to revolve freely in a forked bearing or bushing on the upper end of a light support some distance from the rear end of the head. In this machine a heavy guide is bolted rigidly to the rear end of the head, and extending far enough to reach the end of a 20-ft. bar when in place in the machine. Sliding on this guide is a carrier, revolving in which is a bushing or chuck, with 4 screws spaced evenly around its circumference. By means of this the outer end of the bar can be made to revolve concentrically with the front end and almost perfectly round work can be obtained when using forming tools.

The head, as seen in Fig. 2, is double friction geared, giving 4 spindle speeds without stopping the machine, and if all 3 pulleys of the triple friction countershaft, which is regularly furnished with the machine, are used for "go ahead speeds," 12 spindle speeds can be obtained without stopping the machine. The greatest ratio of gearing is about 20 to 1, while the smallest is about 3 to 1. The cone spindle is driven by a 7-in. belt from a triple friction countershaft, with pulleys 24 ins. in diameter. The machine can be arranged for motor drive if desired.

The cone spindle can be driven direct or through the back gears, the sliding wedge which engages the friction through the fingers being operated by the lever A on the front side of the head. The cone spindle is connected with the main spindle through an intermediate shaft carrying a sleeve gear and pinion meshing into the two large gears on the main spindle. These last two gears are loose on the spindle, and either can be clutched to it as desired by means of the lever B working through a similar friction mechanism to that used on the cone spindle. Babbitt is used for the main spindle and the cone spindle bearings, and the main spindle bearings are oiled through sight feed lubricators located on top of the caps. The front bearing is 8 ins. in diameter by 13 ins. long. The cone spindle has a hole in the centre running almost the entire length, connecting at one end through a stuffing box with a fixed lubricator. Smaller radial holes lead from this central hole to all bearings of the spindle and friction parts, ensuring thorough lubrication, by centrifugal force, from this one source of supply. As this is a fast running shaft, the necessity of some such arrangement as this can be readily understood. The intermediate gear shaft is lubricated in a similar manner, and all gears and rotating parts are fully enclosed.

The stock is held at the front end of the spindle (Fig. 3) by means of a master collet. The false jaws can easily be changed without removing the collet or collet ring from the spindle as the jaw screws extend through large holes in the spindle to a point nearly flush with the outside. A sliding ring covers these holes when the machine is in use. The false jaws are usually serrated to increase their gripping power, and the collet is closed upon the stock by means of the large turnstile on the front of the head which operates the sliding wedge and fingers on the rear end of the spindle. Variation in the size of the bar is provided for by making this wedge with three steps. The collet is adjusted by the nut at the extreme rear end of the spindle, so that the fingers rest on the middle step of the wedge when gripping stock of the correct diameter. If the stock comes a little small the fingers are run up to the large step of the wedge; if a little large they stop at the small step, so that the bar is always securely held.

The feed dog or carrier (Fig. 4), as has already been explained, was designed to serve another purpose besides

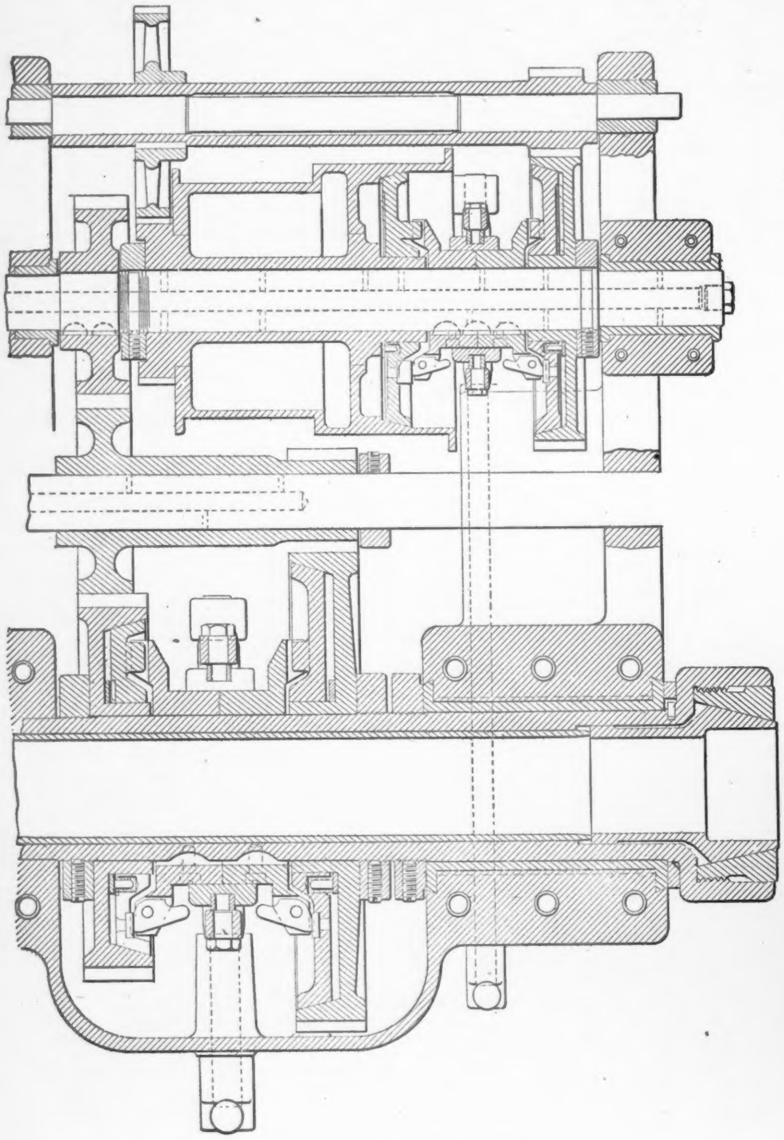


FIG. 2.—SECTION THROUGH HEADSTOCK.

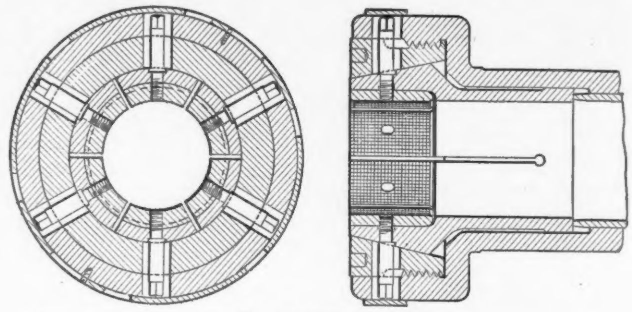


FIG. 3.—MASTER COLLET.

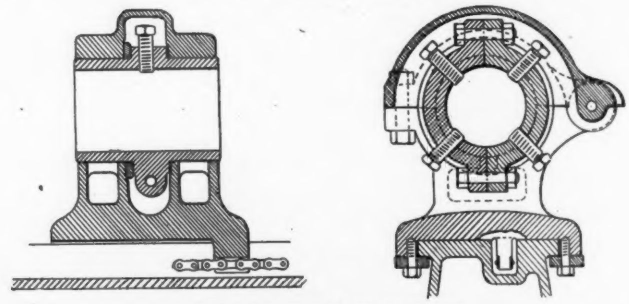


FIG. 4.—FEED DOG OR CARRIER.

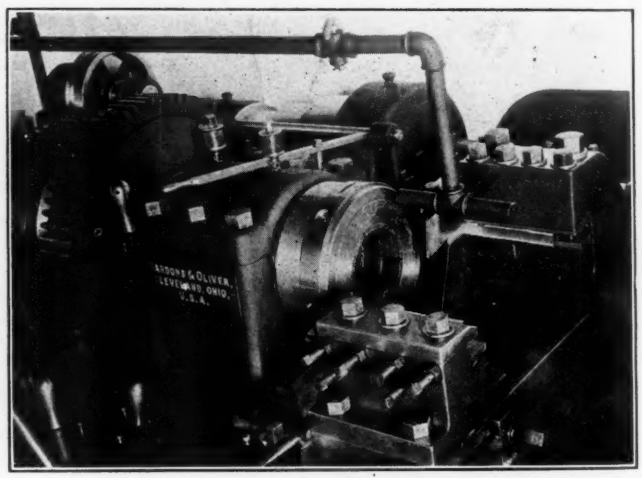


FIG. 5.—COMBINED FORMING AND CUTTING-OFF TOOL SLIDES.

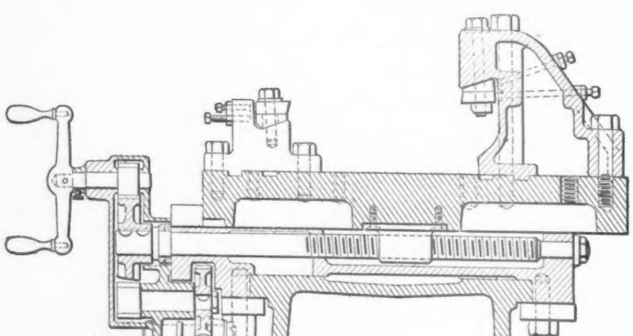


FIG. 6.—FORMING TOOL SLIDE.

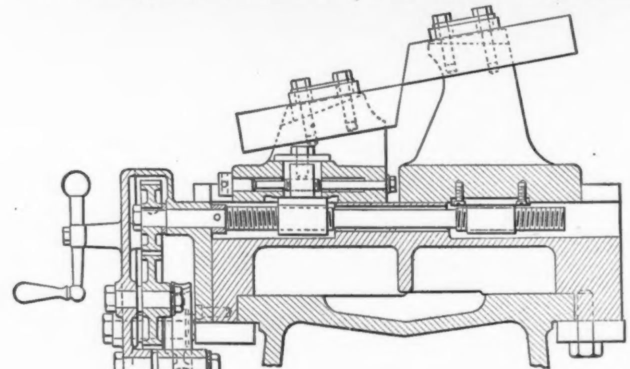


FIG. 7.—CUTTING-OFF TOOL SLIDES.

the mere feeding of the stock. It is in reality a 4-jaw independent chuck by means of which the stock is not only supported at the outer end, but can be made to run concentrically with the spindle at that point, thereby insuring that the finished piece will be round. The feed dog is moved along its bed by means of the smaller turnstile on the front of the head. The shaft of this turnstile passes through the center of the shaft of the turnstile which operates the mechanism for opening and closing the collet. It has been customary to make one turnstile serve both of these purposes, but with this construction, ample power can be had for operating the chuck, while for feeding the stock forward, which requires comparatively little power, a quick motion of indefinite length is obtained. Connection between the smaller turnstile and the feed dog is by means of an endless sprocket chain.

The combined forming tool slide and cutting off tool slides (Fig. 5) is one of the most striking features of the machine, and has been designed for the special purpose of producing as much of the work as possible with wide forming tools fed crosswise against the work rather than with end cuts by the turret tools. Experience obtained in the manufacture of bicycle hubs, projectiles and other irregular-shaped pieces of cir-

cular cross section has demonstrated the superiority of this method wherever practicable. The forming slide (shown in section in Fig. 6) is made long and heavy and carries two massive tool blocks, one at the rear for the roughing tool and one at the front for the finishing tool. Tools to form up to 12 or 14 ins. in length can be held in these holders, which are removable so that special attachments can be fitted for other classes of work when desired. The forming tools are adjusted vertically by means of taper wedges which are moved by screws. They are clamped solidly to the holders by bolts passing directly through them and screws are provided for the lateral adjustment of the tools which can be quickly and accurately set with a little practice. The forming slide can be fed by hand or power in either direction. The power feed has four changes by means of the lever C and the reverse is obtained by the lever D. The feed has an automatic release in either direction. In practice the roughing tool is usually fed by power and the finishing tool by hand. A graduated dial on the handle enables work to be formed accurately as to size.

The cutting-off tools are two in number, mounted on separate slides, shown in section in Fig. 7, which have an entirely inde-

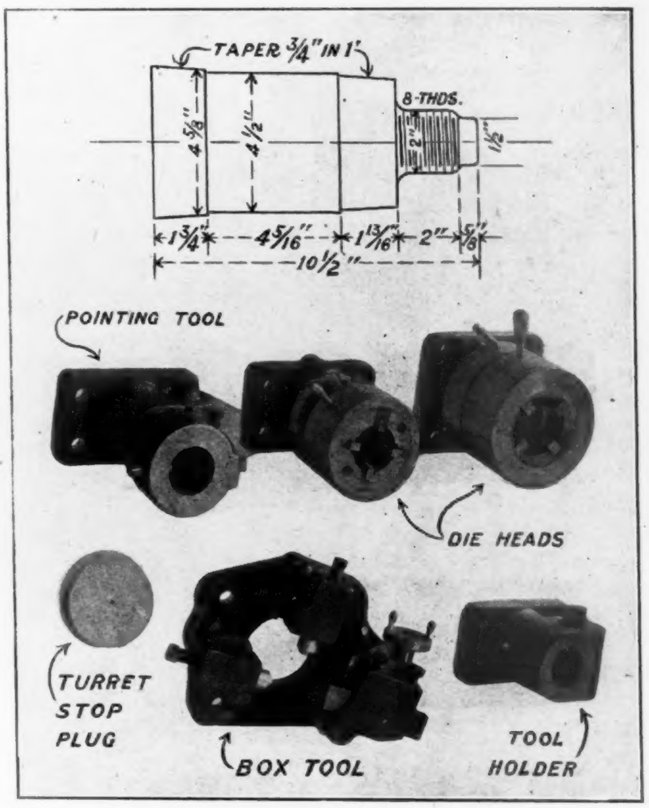


FIG. 8.—WRIST PIN AND TOOLS USED TO MACHINE THREADED END.

pendent cross feed from the forming tool slide, although they are carried on the same saddle casting, this saddle having a longitudinal adjustment of 3½ ins. The cutting-off tool slides are fed in simultaneously by a right and left hand screw either by hand or by power, the power feed being taken from the same shaft as the power feed to the forming slide, but having separate throw-out. The front cutting-off tool slide has an adjustment so that the tools can be set to cut equally and the cutting-off blades are made of high-speed steel and are of special cross section. Four changes of feed can be obtained by means of the lever C.

The turret and turret slide, while amply large, are not so heavy that they cannot be readily operated by hand. As the most severe duty falls on the forming slide, care has been taken in designing the turret and slide not to make them clumsy and difficult to handle. It travels directly on the bed on flat bearings of ample width and wipers on the front end of the slide keep these bearings clean. A taper gib runs the entire length of one side and provides means for taking up side wear.

The turret is hexagon in form, is 18 ins. in diameter across the flats and an independent stop is provided for each of its faces, these stops having a range of 36 ins., while the total feed to the turret slide is 42 ins. Each face has 8, ⅞-in. tapped holes for the purpose of attaching the various tools. There is a 4½-in. hole in each face and also through the center stud, thus enabling work up to 4¼ ins. in diameter and 42 ins. long to be turned. This diameter can be increased if desired. Power feed to the turret slide is provided, and four changes to this feed can be instantly obtained by means of the lever F shown in Fig. 1. The power feed can be tripped at any point by each of the independent stops, which also serve as dead stops for the hand feed. It can be thrown in or out by hand by means of the lever G. The lock bolt is withdrawn by hand by the lever H and the turret is revolved by hand. Means are provided for locking the lock bolt after it is withdrawn if desired, so that the turret can be revolved

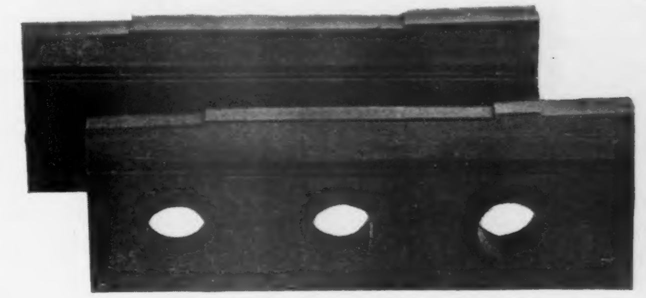


FIG. 9.—FORMING TOOLS USED ON WRIST PIN.

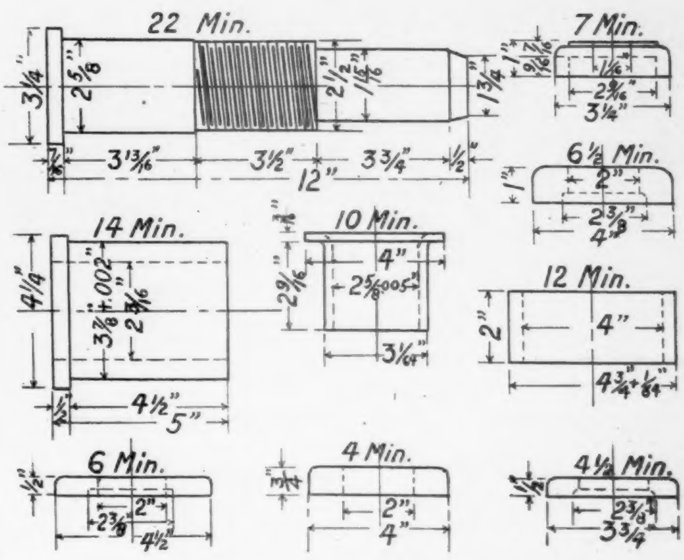


FIG. 10.—SAMPLES OF WORK DONE, WITH TIME REQUIRED.

in either direction past one or more holes. The lock bolt is tapered on the upper end and fits into hardened and ground steel bushings in the bottom of the turret and slides in hardened and ground bushings in the turret slide.

The turret has a large projection on the bottom fitting into a corresponding opening in the top of the slide which serves to take the major part of the thrust, but in addition to this a taper bushing is inserted in the center of the turret taking its bearing on the steel turret stud which extends from the under side of the turret slide to the top of the turret. This bushing is adjustable endwise to take up all wear. The turret stud extends through the large washer on the top of the turret, and is threaded on the outer end to receive the binder handle by means of which the turret and slide can be clamped solidly together.

The base of the machine is cast in the form of a pan which has a large reservoir at the back so that there is room for an abundant supply of lubricant without keeping the pan itself filled. A perforated plate over the reservoir keeps the chips

from entering, and the lubricant that runs down the front side of the machine is conducted back to it quickly through an opening under the center of the bed. There is also an opening in the top of the bed between the turret slide and the forming slide which allows chips and lubricant to fall directly into the back of the pan. A large sheet steel guard extends almost the entire length of the pan at the rear, giving a large chip capacity, and a smaller guard is provided for the front.

The lubricant is forced to the turret, forming and cutting off tools by means of a rotary pump, fastened to the back gear arm. The pump is driven by a belt from a special countershaft, and has a $1\frac{1}{4}$-in. inlet pipe, the end of which is covered by a strainer for further protection from chips. Two 1-in. outlet pipes are provided, one for the turret tools and one for the cut-off and forming tools, through which a continuous stream of lubricant is pumped while the machine is running. The supply of lubricant is directed and controlled by means of levers conveniently located and connected with 3-way valves. An automatic relief valve furnishes an outlet when the discharge is checked or stopped, and the pump can be stopped entirely if so desired by means of the lever, located above the front cap which operates a clutch on the pump shaft.

At each end of the pan lugs are provided by means of which the machine can be readily handled with jacks.

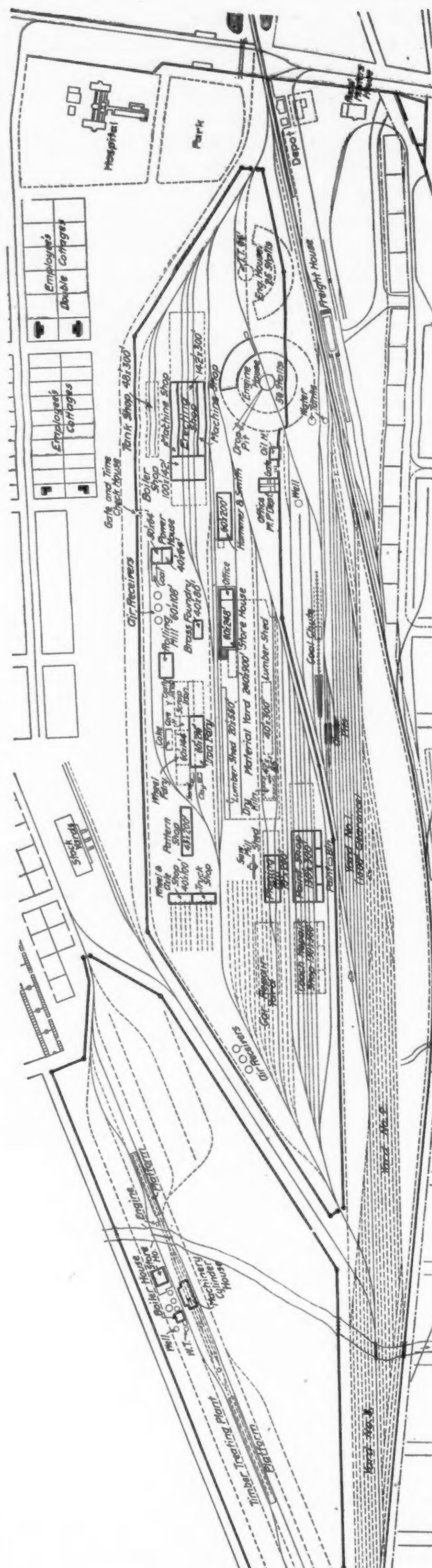
In Fig. 8 is shown a crosshead wrist pin made on this machine from $4\frac{7}{8}$-in. bar stock in 18 minutes. The first operation after chucking was to turn down the small end of the pin from $4\frac{7}{8}$ ins. to 2-in. diameter, and this was done in one cut in 7 minutes by means of the box tool shown in Fig. 8. The cutter is made of high-speed steel and is provided with a releasing mechanism so that the work will not be scored when the tool is being moved back. The back rests, of which there are two, are adjustable in and out so that the work can be backed up at the proper place. The cotter pin end of the wrist pin was turned by means of the pointing tool shown in Fig. 8. This tool is held in the tool holder shown, which is clamped to the face of the turret. By means of these holders tools with shank can be used in the machine. The 2-in. thread is cut by means of a self-opening die head (Fig. 8), which is provided with a roughing and finishing attachment. Only one die head is usually sent with the machine, although two are shown in Fig. 8, one of these being arranged with a sliding holder for use when cutting fine threads. The rest of the wrist pin was machined by the forming tools shown in Fig. 9. These tools are made of high-speed steel, and while the piece was being formed the cutting-off tools were started, thereby saving time. The pieces thus turned out are guaranteed to be within one thousandth of an inch of being round.

Several samples of work done on this machine, with the time it took to finish them, are shown in Fig. 10. This machine is also built to take 6-in. stock, the only change being in the spindle, head parts, automatic chuck and wire feed parts.

AGUAS CALIENTES SHOPS.

MEXICAN CENTRAL RAILROAD.

These shops have been referred to in this journal (see May, 1904, page 181). Because of the climatic conditions the buildings are unique and interesting, they have already been briefly described. The general plan of the plant is illustrated in the accompanying engravings, which indicates completed buildings in solid lines and possible extension in dotted lines. The shop buildings are arranged in a long and somewhat narrow plot enclosed by a 10-ft. adobe wall for protection against thieves. The size of each building is indicated on the drawing. All the shops are arranged on the longitudinal track basis and the plant is characterized by the absence of transfer tables. Buildings for locomotive repairs are grouped at the south end of the enclosure with the roundhouses and oil house nearby. At the other end the car repair department is provided for, with the facilities for storage along the center



GROUND PLAN, AGUAS CALIENTES SHOPS.—MEXICAN CENTRAL RAILWAY.

of the plan. In such a mild climate, most of the heavy supply material is stored out of doors and the storehouse is reserved for small articles and for material requiring special protection from thieves. The power house is at the center of power distribution and the cables are carried on pole lines to the various shops. Two dug wells supply water for the shops and the timber treating plant. A 100,000-gal. steel tank furnishes storage for the shops. A 350,000-gal. reservoir provides a supply to last through the annual dry season.

Of the smaller buildings the hammer and smith shop, 63 by 201 ft., is located near the north end of the erecting machine and boiler shops. Near it are the rolling mill, iron foundry and planing mill. The end walls and side columns of these buildings are of concrete, the roof trusses are of yellow pine and the roofs and side walls of galvanized iron. These buildings are open to a height of 6 ft. 9 in. from the ground. Old rails are used for framing, to which the galvanized iron is fastened. At the south end of the hammer and smith shop the switch and frog work of the entire road is done. The tool equipment and the motors of this shop are presented in tabular form.

The brass foundry is 40 by 80 ft. and is equipped with 6 Morgan furnaces for melting in crucibles. A Tabor pneumatic molding machine is used for making journal bearings. All the journal bearings for the freight equipment of the entire road are filled here.

The iron foundry is 60 by 216 ft., with a leanto addition for charging platforms, core rooms and storage. The core house is 42 by 54 ft., with two ovens, one 18 by 24 ft. and the other 5 by 24 ft. for small work. Two cupolas, a 10-ton Colliau for general use and a 5-ton McKenzie for emergencies are capable of producing an average output of 10 tons daily. Three Tabor molding machines are used for molding brake shoes and other small work. This department requires a total of 50 h.p.

The rolling mill, used for re-rolling scrap, is a building 60 by 108 ft. and is equipped with a 9-in., three high train driven by a vertical engine. Steam is supplied by two locomotive boilers over heating furnaces. The scrap is made into billets under a 2,500-lb. steam hammer and then rolled into bar iron, round and flat.

An adobe building with brick pilasters, 43 by 200 ft., provides for the pattern shop. A 60-ft. room at the south end is the pattern shop proper, the rest of the building being used for pattern storage. A 10-h.p. motor drives a pattern-makers' lathe, a core box machine, a band saw, surfacer rip saw and grindstone. The glue pots are heated by an electric heater.

Truck, wheel and axle work for freight and passenger cars is done in a building 40 by 200 ft., half of which is devoted to trucks. Light car forgings and bolts are also made in this shop.

The planing mill is 70 by 200 ft. with two longitudinal tracks through it. These connect with the yard at the north end and reach the dry kiln and lumber yard at the south end. This building has a floor of vitrified brick laid on edge in sand. This mill turns out all material for car repairs and also provides for manufacturing such material as handles for picks, hammers, axes, etc., used on the road. Near the mill is a sawmill with a 44-in. circular saw with a log carriage, driven by a 30-h.p. motor belted direct to the saw arbor.

These notes are taken from a complete description prepared by Mr. C. T. Bayless, mechanical engineer of the road.

LARGE CONTRACTS FOR LOCOMOTIVE REPAIRS.—The Erie Railroad has awarded to the American Locomotive Company a contract for the repairs of 600 locomotives. This is the largest order of this kind, and the terms require the delivery of 30 locomotives per month, after having received general repairs. It is understood that the arrangement is more profitable to the road than to repair the locomotives themselves after the strenuous conditions of last winter, which left the machinery and boilers in need of unusually heavy work. It is possible for the locomotive company to undertake it because of the falling off in the demand for new locomotives at this time.

DIRECT-CONNECTED MOTOR-DRIVEN FAN.

A very important improvement in the design of their "A B C" direct-connected motor-driven disc ventilating fan, which makes it much more rigid and compact, has recently been made by the American Blower Co. of Detroit. In place of attaching the motor to the arms of the fan, which in many

MOTOR-DRIVEN DISC FAN.—AMERICAN BLOWER CO.

cases was quite objectionable because of the weight of the overhanging motor, it is now placed on a substantial base as shown in the half tone. Westinghouse series-wound multipolar motors are used, which are furnished with an automatic release switch and a fireproof rheostat.

ENGINEER DRAFTSMAN.—The United States Civil Service Commission announces that the examination for engineer draftsman in the supervising architect's office, announced for August 17, 18 and 19, has been postponed to September 14, 15 and 16, 1904, and will be held to secure eligibles from which to make certification to fill a vacancy in the position of engineer draftsman in the supervising architect's office, at $1,200 per annum, and other similar vacancies as they may occur in that office. Information concerning the examinations and places where they will be held may be had on application to the United States Civil Service Commission, Washington, D. C.

RAILROAD ACCIDENTS IN THE UNITED STATES.—The number of persons killed in train accidents during the months of January, February and March, 1904, as shown in reports made by the railroad companies to the Interstate Commerce Commission, under the "accident law" of March 3, 1901, was 221, and of injured 2,797. Accidents of other kinds, including those sustained by employees while at work, and by passengers in getting on or off the cars, etc., bring the total number of casualties up to 919 killed and 12,444 injured. These reports deal only with passengers and employees on duty.

TRACTIVE RESISTANCE ON VARIOUS ROADS.—The tractive resistance on railroads is from 9 to 18 lbs. per ton, on tramways 26 to 33 lbs., on good stone pavement from 44 to 55 lbs., on bad stone pavement from 66 to 78 pounds, on good macadam from 44 to 67 lbs., on bad macadam from 77 to 100 lbs., and on sand roads from 130 to 220 lbs.—*Max Schiemann.*

The Western Transit Company, which is the freight connection of the New York Central & Hudson River Railroad on the Great Lakes, has recently put into commission the new steamer Duluth, the largest package freight vessel on the Great Lakes. It is 401 ft. long, has a 50-ft. beam and 30-ft. depth, with a carrying capacity of 6,000 tons. This makes seven modern steel steamers in the Western Transit Company's fleet, six of which has been added since 1898, it being the company's policy to add a new steamer each year. In addition to these steel steamers, the company has nine iron and wooden ones, and this fleet of sixteen steamers enables the New York Central to give a daily freight service from Buffalo to Milwaukee, Chicago, Duluth and Portage Lake.

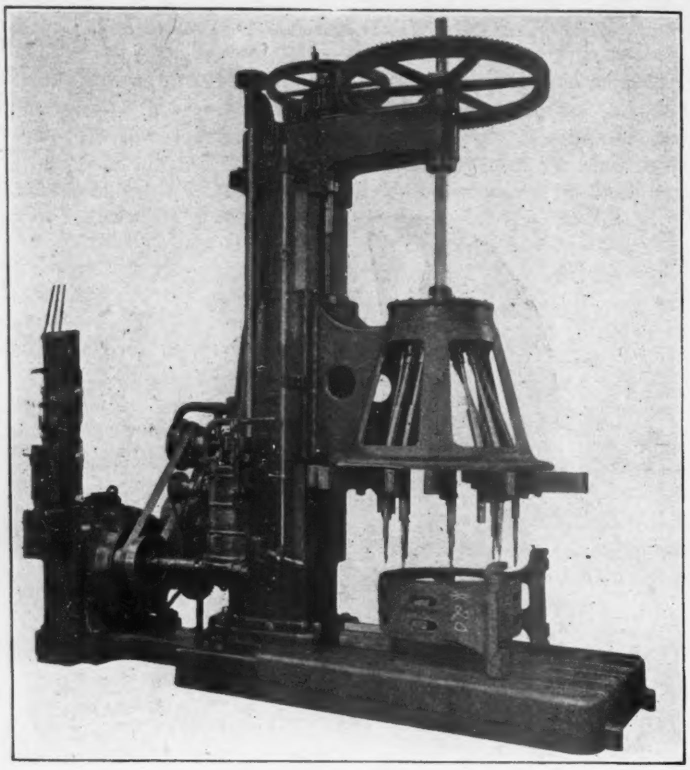


FIG. 1.—MULTIPLE SPINDLE DRILL.—BAUSH MACHINE TOOL COMPANY.

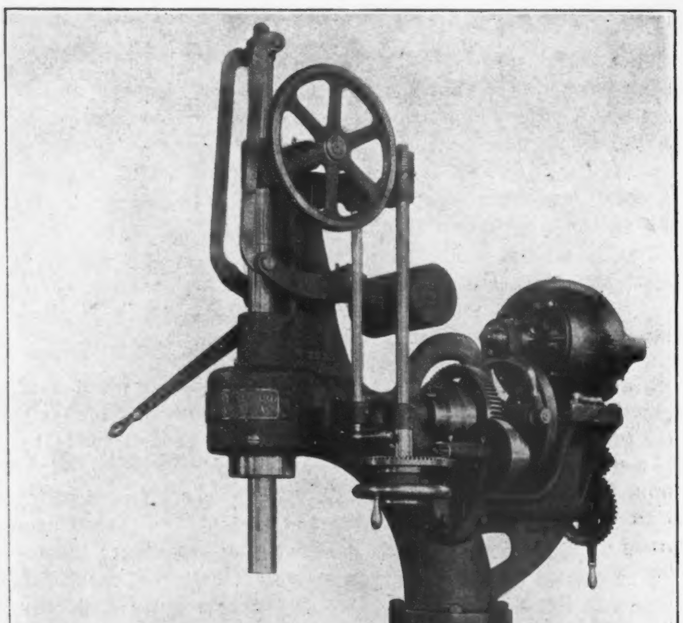


FIG. 3.—NEAT MOTOR APPLICATION TO BEMENT, MILES & CO. DRILL PRESS.

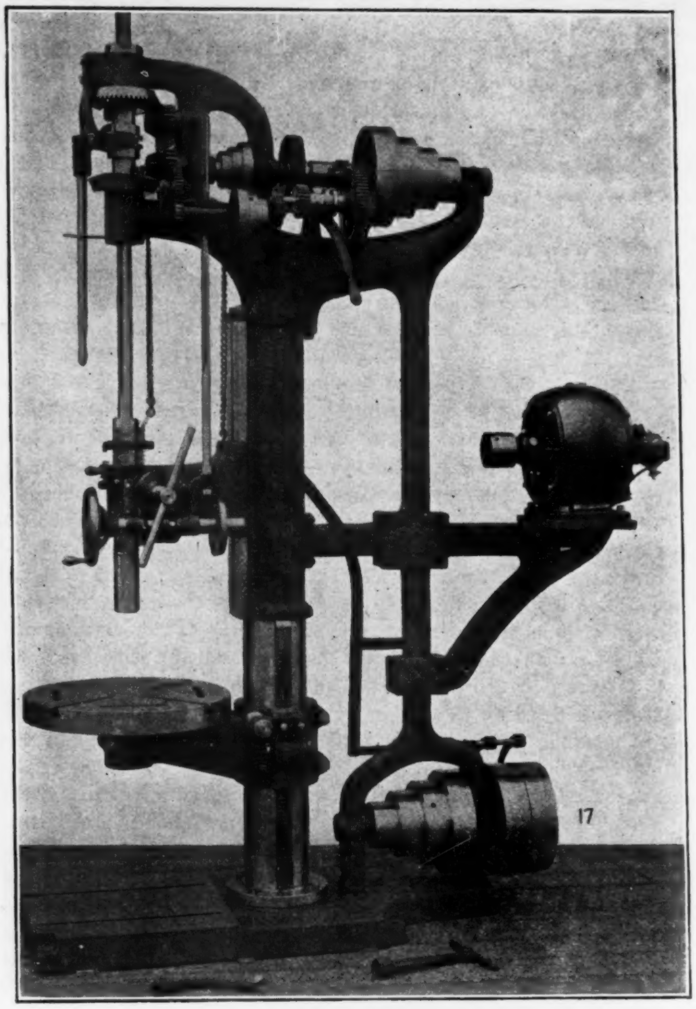


FIG. 2.—STANDARD DRILL PRESS ARRANGED FOR MOTOR DRIVE. CINCINNATI MACHINE TOOL CO.

DRILLING MACHINES.

Fig. 1 illustrates a fourteen-spindle multiple drill built by the Baush Machine Tool Company, Springfield, Mass., and driven by a General Electric Company variable speed 10 h.p., C. K. type motor with a speed range of from 350 to 700 r.p.m. The motor is placed on an extension of the base of the machine and is connected to the driving mechanism by gearing. The machine is designed to drill from one to fourteen 1-in. holes in cast iron with a maximum circle of 36 ins. and a minimum circle of 14 ins. The spindles are adjustable to allow for drilling in groups of square, circular or other forms, using one or more spindles and are also adjustable vertically. The automatic stop and feed permits the head to be operated with great ease and rapidity and relieves the workman of much unnecessary handling. It can also be operated by hand if desired. The machine has a quick return mechanism which can be controlled either automatically or by hand. Its weight is 23,000 lbs. These machines can be made either vertical or horizontal, and the horizontal machine can be made with either single or double head, each of which will carry from one to twenty spindles, ranging from ½ to 1½ ins. in diameter.

Fig. 2 illustrates the neat manner in which the Cincinnati Machine Tool Co. can easily arrange one of their standard drill presses for a motor drive. The motor bracket is of simple design and is clamped to the frame at the rear. The motor shown is a 2 h.p. Northern Electric and is mounted to belt to the tight and loose pulleys. Another interesting feature of this machine is the geared tapping attachment. The lever which hangs parallel to the main spindle operates a double clutch which engages the spindle with either train of gearing, rotating it in either direction, or allowing it to go free if the clutch is in its middle position as shown in the illustration. The clutches can readily be engaged or disengaged while the machine is in motion, thereby allowing the operator to

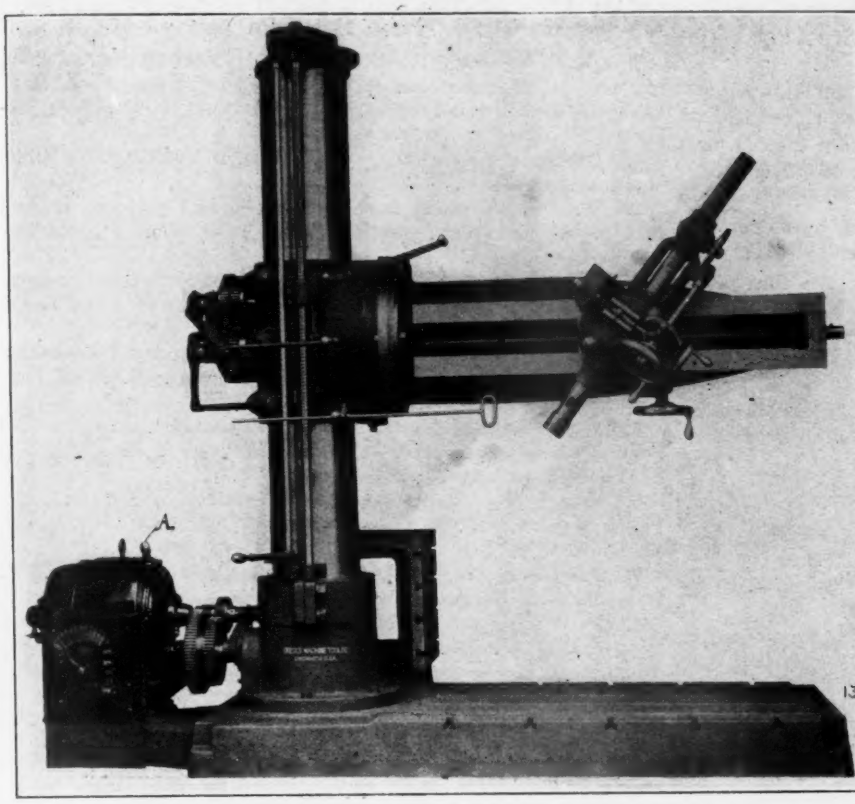


FIG. 4.—MOTOR-DRIVEN RADIAL DRILL.—DRESES MACHINE TOOL CO.

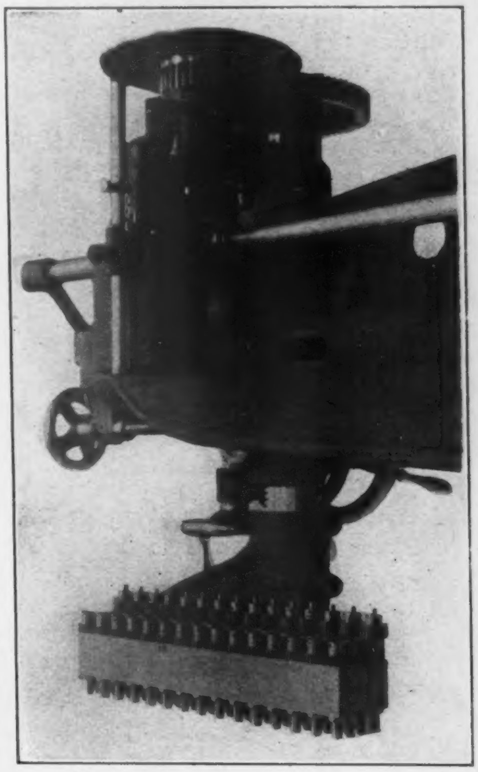


FIG. 7.—MULTIPLE DRILLING DEVICE.—MUELLER MACHINE TOOL CO.

drill a hole, remove the drill and substitute a tap, and tap the hole without stopping the machine.

Fig. 3 shows a 50-in. vertical drill made by Bement, Miles & Company, and on exhibition at the St. Louis Exposition. Attention is at once attracted to the neat and substantial way in which the motor is applied. The 2½-h.p. Northern Electric motor has a speed range from 350 to 1,750 r.p.m. by speed control, giving in combination with the change gears, spindle speeds from 8½ to 220 r.p.m. The spindle is counterweighted and the bevel gears which drive it run in oil and are enclosed in a dustproof casing. It has power and hand feeds and rapid vertical adjustment by hand lever, and has 18 ins. traverse. The table has compound slides and vertical adjustment by power.

A full universal motor-driven radial drill made by the Dreses Machine Tool Company is shown in Fig. 4. The motor is a 3½-h.p. Jantz & Leist with a 2 to 1 speed variation and is connected to the drill shaft by two friction gears operated by the lever A. The two pinions keyed to the motor shaft are rawhide in order to insure noiseless running. The changes in the motor speed are obtained by shunt resistance, and these in connection with changes obtained by means of the two friction gears operated by lever A and by the regular change gear mechanism on the rear end of the arm afford a wide speed range with a large number of steps.

The adjustable handle rod below the arm starts, stops, engages the back gears, and reverses the spindle quickly for tapping, all while the machine is running and without using the belt shifter. The brake power of the driving friction gears on the rear of the arm can be adjusted so that the spindle will slip at a certain strain; for instance, when the tap strikes the bottom of the hole. The feed is positive and can be varied while the machine is drilling.

Figs. 5 and 6 show an interesting motor application made to a 5-ft. Dreses radial drill furnished to the Pittsburgh & Lake Erie Railroad for their McKees Rocks shops. The motor is a Crocker-Wheeler Company 6½-h.p. vertical and is mounted as shown in Fig. 6. With the belt drive the shaft P (extended) was driven from the cone pulley shaft by means of a pair of bevel gears and motion was transmitted to shaft O by means of gears D and C. With the motor drive the rawhide pinion A on the armature shaft drives gear B and shaft O which in turn transmits motion to the drill gearing. Gears C, D and E drive the elevating screw S by means of a tumbler gearing arrangement. The motor controller is mounted above the motor and is operated by means of the

FIG. 5.—VERTICAL MOTOR APPLIED TO DRESES RADIAL DRILL.

handwheel on the vertical shaft, which is clearly shown on the half tone, and is connected to the controller shaft by a pair of bevel gears.

The half tone (Fig. 7) shows a new drilling device applied to a radial drill, permitting 60 holes to be drilled at the same time by operating the usual feed levers. The main casting, or head, is clamped to the machine sleeve, which is raised and lowered by means of its rack and pinion.

The radial spindle runs loose in this head, and, by means of teeth cut on the spindle next to the sleeve, drives the sixth gear in the first row of 15 spindles, which mesh together. These spindles have 1½-in. centers, and each of them drives three others in rows at right angles to the first row. Their

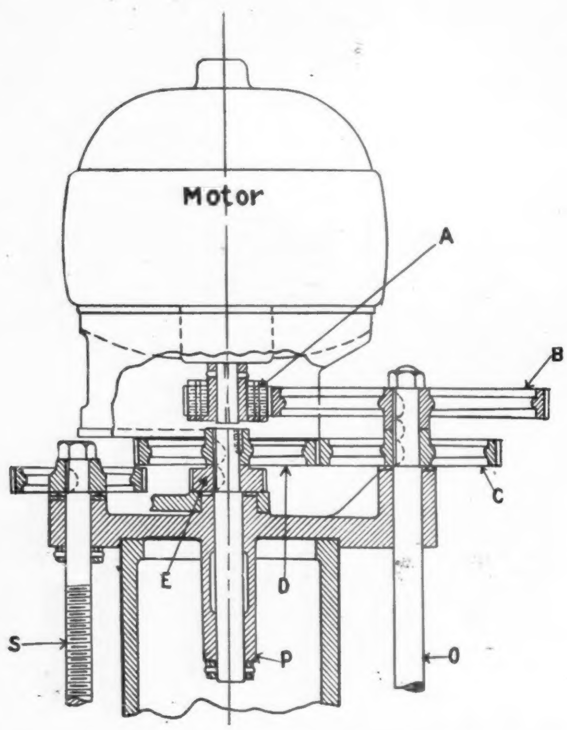


FIG. 6.—DETAILS OF APPLICATION OF VERTICAL MOTOR TO DRESES RADIAL DRILL.

centers are 1⅛ ins. in order to allow the teeth of their gears to pass each other as they run in opposite directions, and 30 right and 30 left hand drills are used to do the drilling. With the aid of a graduated dial on the cross screw and a table having its adjustment at right angles to the radial arm thousands of holes can be drilled with accuracy, down to ¼ in. center distances. The speed of the small drill spindles is about twice that of the main spindle. This device is manufactured by the Mueller Machine Tool Company of Cincinnati, Ohio.

Mr. George R. Henderson has opened an office at 20 West Thirty-fourth street, New York City, as a consulting engineer, with railroad problems as a specialty. His education, training and experience of 25 years' service on such roads as the Pennsylvania, Norfolk & Western, Chicago & Northwestern and Santa Fe, together with his high standing as an engineer, constitute a most excellent preparation for consulting practice, and in view of the important new problems now presented to railroad management, this journal is glad to note that Mr. Henderson has decided upon this course.

CAR AND LOCOMOTIVE PAINTERS' ASSOCIATION.

The Master Car and Locomotive Painters' Association will hold its thirty-fifth annual convention at Atlantic City, N. J., September 13 to 16, with headquarters at the Hotel Rudolf. The program of subjects is as follows:

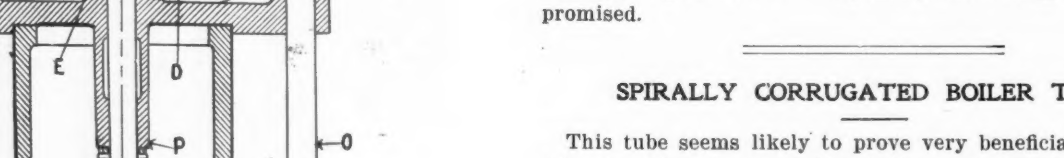
1. Report of committee on tests. J. H. Pitard, Mobile & Ohio, chairman.
2. What improvement have we made in the painting of steel cars in the past year? Robert Shore, Lake Shore & Michigan Southern, chairman.
3. What is the best material and treatment for locomotive front ends? A. R. Lynch, Pittsburg, Cincinnati, Chicago & St. Louis, chairman.
4. What is the best construction of sand blast and method of operating same, in preparing metal for painting? J. H. Kahler, Erie Railroad, chairman.
5. Which is the best method for removing cracked varnish on the interior of passenger cars? Chris. Clark, New York, Chicago & St. Louis, chairman.
6. Essay, "The Treatment of an Ideal Passenger Car from a Painter's View." J. A. Gohen, Cleveland, Cincinnati, Chicago & St. Louis.
7. Passenger car roofs—treatment and attention of same. T. J. Hutchinson, Grand Trunk, chairman.
8. Paint shop, records, and accounts. H. M. Butts, New York Central & Hudson River, chairman.
9. What causes the bulging of putty in the nail holes of new work? J. H. Whittington, Chicago & Alton, chairman.

TRAVELING ENGINEERS' ASSOCIATION.

This association will hold its annual convention at the Lexington Hotel, Michigan Boulevard and Twenty-second street, Chicago, September 13. A specially interesting convention is promised.

SPIRALLY CORRUGATED BOILER TUBES.

This tube seems likely to prove very beneficial in reducing "flue troubles" in locomotive boilers. It has been in experimental service for five years with excellent results. The body of the tube is corrugated in spirals of 3¾-in. pitch, the ends being plain for a length of 8 ins. at both tube sheets, these portions being thicker than the body of the tube. Advantages of two kinds are offered by this tube. First, the corrugations render the tube elastic and the expansion and contraction are taken up in the tube itself instead of being transmitted to the tube sheets. Because of the peculiarly severe conditions of locomotive service this is an important matter. By applying tension to a single tube by mechanical means it is demonstrated that the tube may be stretched ⅜ in. in 16 ft. with no permanent set. Second, the spiral corrugations tend to break up the currents of hot gases passing through the tubes, the action being similar to that of "retarders" or the fins of the well known Serve tubes, in abstracting a larger amount of heat from the gases than may be obtained with smooth tubes. This should improve the economical performance of a boiler. It is evident that anything which increases the absorption of heat from the gases not only increases the economy, but reduces the necessity for forcing the fire, the value of which will appear in the form of enlarged exhaust nozzles and a decrease of waste through spark throwing.



SPIRALLY CORRUGATED BOILER TUBE.

Practical tests are believed to show that the corrugations do not collect cinders, that there is a marked saving in fuel a great improvement with respect to tube leakage and a reduction in the number of sparks thrown. An important reference

to these tubes may be found on page 85 of the Proceedings of the Master Mechanics' Association for 1903. The following record has been received from a road having these tubes in service for five years:

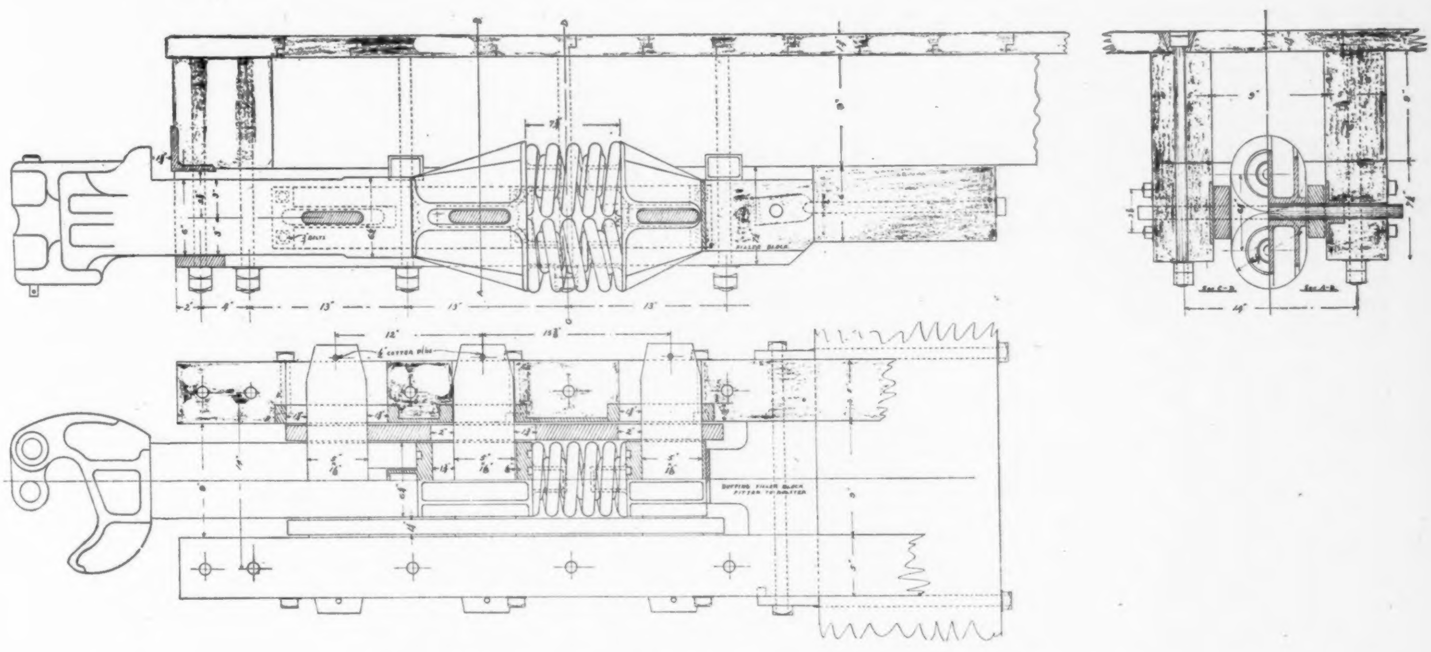
PERFORMANCE OF ENGINES EQUIPPED WITH CORRUGATED AND PLAIN TUBES.

No. Engine	Tubes	Mileage	Lbs. coal used	Weight train hauled in net tons	Per Mile. Lbs. coal	Per Mile. Tons haul'd	Tons hauled per ton coal used
67	Corrugated	1,200	63,300	1,338	52.75	1.11	42.28
69	Plain.....	1,200	60,800	1,188	50.67	0.99	39.08
							8.18%

The exhibit of these tubes at the recent Saratoga Convention attracted a great deal of interested attention among railroad men who are facing serious flue troubles, and the tubes are now being tried on a number of the most prominent roads. Further information may be obtained from the manufacturers, The New Jersey Tube Co., Newark, N. J.

point of this gear. There is no yoke to be riveted on or cut off, and no blacksmith work whatever about the gear or its attachments. Strength, however, has not been sacrificed to convenience. In a test made at Purdue University a gear, which was exhibited at the recent Saratoga conventions, withstood 30 blows (beginning at 1 ft. 1 in. and ending at 30 ft. 1 in. drop) and finished in condition for service under a car. At the fourth blow the horn of the coupler struck the end sill.

A twin spring arrangement is illustrated, but the tandem, single spring, or a friction gear may be applied as desired, and any of these forms may be readily applied to old equipment. Other interesting features are the initial compression of the springs by driving in the keys with the taper ends and the fact that the gear will do its work even if a spring is broken and lost in transit. Further information may be had from the Farlow Draft Gear Company, 223 North Calvert Street, Baltimore, Md.



FARLOW DRAFT GEAR—TWIN SPRING—APPLIED TO WOOD DRAFT SILLS.

THE FARLOW DRAFT GEAR.

This gear was designed to provide the necessary strength and capacity to resist shocks of service in a construction which is easily repaired. Many gears which are satisfactory in every other respects are difficult to repair, and few are so made as to be taken down and replaced by one man. The Farlow draft gear combines a coupler, with the elongated slot; front and rear followers, also slotted; three keys, passing through the slots in the drawbar and followers and also passing through the draft sills or draft castings and two slotted drawbar links, one at each side of the coupler.

The arrangement is illustrated in the accompanying engraving. In addition to the keys for taking buffing shocks, the rear face of the rear follower is broadened to bear against an oak block which is bolted between the draft timbers and bears against the followers at the front end and against the body bolster at the back end, thus adding to the buffing resistance. In buffing, or in pulling, the springs transmit the initial shock to the sills through the links and the three 5-in. keys. These keys are in shear, and bending stresses are avoided. The horn of the coupler strikes when the keys come to a bearing, after which the buffing shocks are transferred to the buffing block bearing against the bolster. The resistance of the keys prevents the springs from being compressed "solid." Because of the keys, which are easily applied and removed, and the slotted draw links, this gear is very easily put up and taken down. It should permit of establishing a low piece-work price for repairs. In fact, this convenient construction is a strong

LOCOMOTIVE TESTING PLANT AT ST. LOUIS.

SCHEDULE FROM OBSERVED DATA.

On page 301 of the August number the beginning of the schedule of data taken from Bulletin No. 3 was presented. This list is continued in abstract below because of the value of the schedule itself. The notes will be completed next month. These bulletins may be purchased from the Pennsylvania Railroad:

OBSERVED DATA.

196. Duration of test, hours....................

SPEED.

197. Total revolutions....................
198. Average revolutions per minute....................
199. Equivalent speed in miles per hour....................
200. Equivalent piston speed in feet per minute....................

POSITION OF LEVERS.

201. Reverse lever, notches from front end....................
203. Throttle lever....................

TEMPERATURE, DEGREES FAHRENHEIT.

206. Of smoke-box, by thermometer....................
207. Of smoke-box, by pyrometer....................
208. Of laboratory, dry bulb....................
209. Of laboratory, wet bulb....................
210. Of steam in branch pipe....................
211. Of feed water....................
212. Of fire-box, by pyrometer....................

PRESSURE, POUNDS PER SQUARE INCH.

217. In boiler, average....................
218. In boiler, maximum....................
219. In boiler, minimum....................
220. In branch pipe....................
221. In laboratory, barometric....................

DRAFT, INCHES OF WATER.

222. In smoke-box, front of diaphragm....................
223. In smoke-box, back of diaphragm....................
224. In fire-box....................
225. In ash pan....................

INJECTORS.

Hours in action.

226. Total, right ....
227. Total, left ....

QUALITY OF STEAM.

228. In dome ....
229. In branch pipe ....
230. Degrees of superheat in branch pipe....

COAL, SPARKS AND ASH.

232. Coal fired, kind....
233. Coal fired, total, pounds....
234. Coal as fired, per cent, of moisture....
235. Dry coal fired, total, pounds....
236. Combustible, by analysis, total, pounds....
237. Ash, by analysis, total, pounds....
238. Cinders collected in smoke-box, total, pounds....
239. Sparks discharged from stack, total, pounds....
240. Cinders and sparks, total, pounds....

ANALYSIS OF COAL.

241. Fixed carbon, per cent....
242. Volatile matter, per cent....
243. Moisture, per cent....
244. Ash, per cent....
245. Sulphur determined separately, per cent....

CALORIFIC VALUE IN B. T. U., PER LB.

248. Of dry coal....
249. Of combustible ....
250. Of cinders and sparks ....

ANALYSIS OF SMOKE-BOX GASES.

253. Oxygen—O, per cent....
254. Carbon monoxide—CO, per cent....
255. Carbon dioxide—CO_2, per cent....
256. Nitrogen—N, per cent....

WATER, IN POUNDS.

259. Delivered to injectors....
260. Lost, from boiler....
261. Lost, from....
262. Lost, from....
263. Lost, total ....
264. Delivered to boiler and presumably evaporated....

DYNAMOMETER.

Pull in pounds.

265. Average ....
266. Maximum ....
267. Minimum ....

CUT-OFF, PER CENT. OF STROKE.

268. High pressure cylinder, right, head end....
269. High pressure cylinder, right, crank end....
270. High pressure cylinder, left, head end....
271. High pressure cylinder, left, crank end....
272. Low pressure cylinder, right, head end....
273. Low pressure cylinder, right, crank end....
274. Low pressure cylinder, left, head end....
275. Low pressure cylinder, left, crank end....

RELEASE, PER CENT. OF STROKE.

276. High pressure cylinder, right, head end....
277. High pressure cylinder, right, crank end....
278. High pressure cylinder, left, head end....
279. High pressure cylinder, left, crank end....
280. Low pressure cylinder, right head end....
281. Low pressure cylinder, right, crank end....
282. Low pressure cylinder, left, head end....
283. Low pressure cylinder, left, crank end....

BEGINNING OF COMPRESSION, PER CENT OF STROKE.

284. High pressure cylinder, right, head end ....
285. High pressure cylinder, right, crank end ....
286. High pressure cylinder, left, head end....
287. High pressure cylinder, left, crank end....
288. Low pressure cylinder, right, head end....
289. Low pressure cylinder, right, crank end....
290. Low pressure cylinder, left, head end....
291. Low pressure cylinder, left, crank end....

PRESSURE FROM INDICATOR CARDS.

Initial pressures, pounds per sq. inch.

292. High pressure cylinder, right, head end....
293. High pressure cylinder, right, crank end....
294. High pressure cylinder, left, head end....
295. High pressure cylinder, left, crank end....
296. Low pressure cylinder, right, head end....
297. Low pressure cylinder, right, crank end....
298. Low pressure cylinder, left, head end....
299. Low pressure cylinder, left, crank end....

STEAM CHEST PRESSURES, POUNDS PER SQ. IN.

301. High pressure, right side....
302. High pressure, left side....
303. Low pressure, right side....
304. Low pressure, left side ....

PRESSURES AT CUT-OFF, POUNDS PER SQ. INCH.

306. High pressure cylinder, right, head end....
307. High pressure cylinder, right, crank end....
308. High pressure cylinder, left, head end....
309. High pressure cylinder, left, crank end....
310. Low pressure cylinder, right, head end....
311. Low pressure cylinder, right, crank end....
312. Low pressure cylinder, left, head end....
313. Low pressure cylinder, left, crank end....

PRESSURES AT RELEASE, POUNDS PER SQ. INCH.

314. High pressure cylinder, right, head end....
315. High pressure cylinder, right crank end....
316. High pressure cylinder, left, head end....
317. High pressure cylinder, left, crank end....
318. Low pressure cylinder, right, head end....
319. Low pressure cylinder, right, crank end....
320. Low pressure, cylinder, left head end....
321. Low pressure cylinder, left, crank end....

PRESSURES AT BEGINNING OF COMPRESSION, POUNDS PER SQ. INCH.

322. High pressure cylinder, right, head end....
323. High pressure cylinder, right crank end....
324. High pressure cylinder, left, head end....
325. High pressure cylinder, left, crank end....
326. Low pressure cylinder, right, head end....
327. Low pressure cylinder, right, crank end....
328. Low pressure cylinder, left, head end....
329. Low pressure cylinder, left, crank end....

LEAST BACK PRESSURE, POUNDS PER SQ. INCH.

330. High pressure cylinder, right, head end....
331. High pressure cylinder, right, crank end....
332. High pressure cylinder, left, head end....
333. High pressure cylinder, left, crank end....
334. Low pressure cylinder, right, head end....
335. Low pressure cylinder, right, crank end....
336. Low pressure cylinder, left, head end....
337. Low pressure cylinder, left, crank end....

SUMMARY OF AVERAGE RESULTS.

Boiler.

338. Dry coal fired, per hour, pounds....
339. Dry coal fired, per hour, per sq. ft. of grate surface, pounds....

EVAPORATION, POUNDS.

340. Moist steam per hour....
341. Dry steam per hour....
342. Dry steam per hour, per sq. ft. of heating surface....
343. Dry steam per hour, per pound of dry coal....

EQUIVALENT EVAPORATION FROM AND AT 212 DEGREES FAHR.

344. Per hour, pounds....
345. Per hour per sq. ft. of heating surface, pounds....
346. Per pound of coal as fired, pounds....
347. Per pound of dry coal, pounds....
348. Per pound of combustible, pounds....
349. Boiler horse power....
350. Efficiency of boiler....

SUMMARY OF AVERAGE RESULTS—ENGINE.

MEAN EFFECTIVE PRESSURE, POUNDS PER SQ. INCH.

351. High pressure cylinder, right, head end....
352. High pressure cylinder, right, crank end....
353. High pressure cylinder, left, head end....
354. High pressure cylinder, left, crank end....
355. Low pressure cylinder, right, head end....
356. Low pressure cylinder, right, crank end....
357. Low pressure cylinder, left, head end....
358. Low pressure cylinder, left, crank end....

RECEIVER.

359. Pressure, right side....
360. Pressure, left side....

NUMBER OF EXPANSIONS.

361. Right side, head end....
362. Right side, crank end....
363. Left side, head end....
364. Left side, crank end....

INDICATED HORSE POWER.

365. High pressure cylinder, right, head end....
366. High pressure cylinder, right, crank end....
367. High pressure cylinder, left, head end....
368. High pressure cylinder, left, crank end....
369. Low pressure cylinder, right, head end....
370. Low pressure cylinder, right, crank end....
371. Low pressure cylinder, left, head end....
372. Low pressure cylinder, left, crank end....

DIVISION OF POWER.

373. High pressure cylinder, right side....
374. High pressure cylinder, left side....
375. Low pressure cylinder, right side....
376. Low pressure cylinder, left side....
377. Right side, total....
378. Left side, total....
379. Total ....

PER I. H. P. PER HOUR.

380. Dry coal, pounds....
381. Dry steam, pounds....
382. B. T. U. ....

SUMMARY OF AVERAGE RESULTS—LOCOMOTIVE.

383. Dynamometer horsepower....
384. Dry coal per D. H. P. per hour, pounds....
385. Dry steam per D. H. P. per hour, pounds....
386. B. T. U. per D. H. P. per hour, pounds....

PER ONE MILLION FOOT POUNDS AT DRAWBAR.

387. Dry coal, pounds....
388. Dry steam, pounds....
389. B. T. U. ....
390. I. H. P. per square foot of heating surface....
391. I. H. P. per square foot of grate surface....
392. D. H. P. per square foot of heating surface....
393. D. H. P. per square foot of grate surface....
394. Tractive power based on M. E. P., pounds....

MACHINE FRICTION OF LOCOMOTIVE IN TERMS OF,

395. Horse power ....
396. M. E. P., pounds....
397. Drawbar pull, pounds....

EFFICIENCY.

398. Machine efficiency of locomotive, per cent....
399. Efficiency of locomotive, per cent....

RATIOS.

400. Total weight of locomotive to maximum I. H. P....
401. Total heating surface to maximum I. H. P....

SUMMARIZED STATEMENT OF AVERAGE RESULTS.

196. Duration of test hours....
198. Number of rev. per min....
199. Speed in miles per hour....
203. Position of throttle....
217. Boiler pressure in pounds per sq. in....
220. Branch pipe pressure in pounds per sq. in....
222. Draft in front of diaphragm, inches of water....
265. Drawbar pull, pounds....
268 to 271. Approximate cut-off in high pressure cylinder, in per cent of stroke ....
338. Dry coal fired per hour, pounds....
341. Dry steam used per hour, pounds....
344. Equivalent number of pounds of water from and at 212 degrees Fahr. per pound of dry coal....
350. Efficiency of boiler....
379. Indicated horse power....
380. Dry coal per I. H. P. per hour, pounds....
381. Dry steam per I. H. P. per hour, pounds....
383. Dynamometer horse power ....
384. Dry coal per D. H. P. per hour, pounds....
385. Dry steam per D. H. P. per hour, pounds....
395. Frictional horse power ....
399. Efficiency of locomotive....

(The explanatory notes will be concluded next month.)

THE ATLANTIC STEAM SHOVEL.

The 2½-yard steam shovel illustrated in this engraving is a new machine introduced by the Atlantic Equipment Company, of 25 Broad street, New York. It is built by the American Locomotive Company from the designs of A. W. Robinson, M. Am. Soc. C. E. This machine is the result of many years' experience in the design and operation of steam shovels and dredging machines, and it includes all the desirable features of the best modern practice in shovel building. The Atlantic shovel has been designed to cover the following points as compared with others:

1. Simplicity of design with direct strain, and few and strong parts that will not break or easily get out of order. 2. The highest possible speed and power consistent with safe and effective working. 3. Avoidance of wear and breakage of chains and sheaves. 4. Moderate weight. 5. Better and more efficient boiler for easy steaming and economy of fuel. 6. Direct application of power to the dipper. 7. Better angle of lead, giving more digging power with less pull on dipper. 8. One sheave instead of six. 9. Sixty-five to 85 per cent. greater efficiency. 10. High lift. 11. Short boom, thus reducing the strains and permitting faster speed of swinging. 12. The employment throughout of the highest quality of design, materials and workmanship and fully equal to the best locomotive practice.

It has a pull upon the dipper of 38,000 lbs., a clear height of lift of 16 ft. and a capacity of 2½ cu. yds.

The distinguishing feature of this shovel is the direct wire rope hoist. Direct wire rope hoists have been used successfully by Mr. Robinson for some years in large dipper dredges, and his work in this connection is well-known.

The hoisting engines are incorporated in the base of the boom so that the whole hoisting machinery revolves together. The hoisting machinery is unusually compact and at the same time very strong and easy of access. The drum is very short and of large diameter and fits easily between the sides of the boom which constitute the frame. The gearing is of steel and amply strong to stall the engines with full head of steam. The hoisting friction is of novel type, taking up less room than usual and is quick and sensitive and does its work without heating. It is operated by steam so that the operator exerts no effort. The A frame is formed of solid steel bars having solid forged pin-connections at feet and a cast steel head. The A frame is stepped upon the ends of the jack-arm truss in such a way that it forms a continuation of the jack-arms, giving great stability and relieving the car frame from strains. The A frame head is of new design and arranged so that the three strains intersect in a point. This is accomplished in no other shovel and obviates all lateral bending strains which frequently lead to breakage. The A frame can be lowered when required for transportation over the road to 15 ft. (or lower) above the rail. The pin-connections at the foot of the frame permit of this movement and the back guys are shifted forward to a connection provided for the purpose. The raising and lowering of the frame can be done by power.

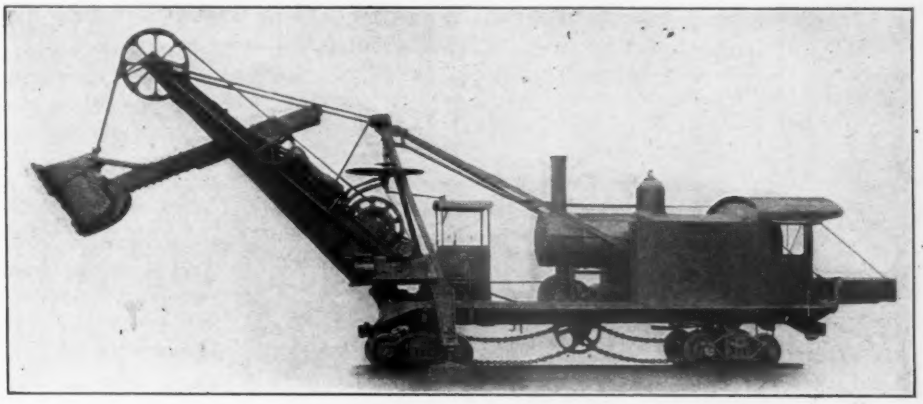
The boom has a straight taper deepest at the inner end. This form is the simplest and most direct that can be devised, giving the greatest strength where it is needed and the least weight at outer end where there is greatest motion.

The turntable is built solid with the boom, being made of stiffened steel plates and a rolled rim. The turntable and boom as a unit have perfect freedom of action, being separate from the revolving collar on the base. In this shovel the hoisting machinery is mounted directly upon the boom so that no guide sheaves are necessary, and the power is applied in the most direct and simple manner and with the least possible loss. A pair of engines with drum and gearing are incorporated into the base of the boom that take up very little room and can pull the required amount on the dipper at a speed of five to six dipper loads per minute, and in which all parts are adequate for continuous heavy work and easily accessible.

The main engines are of locomotive type with outside cylinders. A sheet steel casing is provided for protection. They have solid cast steel frame for both engines in one piece and steel crossheads, with all parts easy of access. Steam is carried by a pipe having a double ball and socket joint on top center, and the exhaust is carried to the smokestack by a pipe through the bottom center. The hoisting drum is of large diameter, grooved for steel wire rope.

Independent thrusting engines are employed to feed the dipper to its work. By their use the cranesman has absolute control of the dipper and can cause it to fill every time while in a proper bank. These engines are solidly built with bedplate in one piece and well bolted to the boom. The gearing is of steel and the engines are reversing by means of central valve. Independent reversible engines are employed for swinging, a duplicate of those on the boom for thrusting, and double-geared to a drum. The drum carries double steel wire ropes on each side, which are connected to the turntable.

In this shovel there is room for a first-class locomotive boiler, and the greatest care is bestowed upon its design and workmanship. It is large enough for a locomotive of twice



THE ATLANTIC STEAM SHOVEL.

the cylinder capacity, and is, therefore, easy steaming. It is built for a working pressure of 140 lbs., which more nearly accords with locomotive practice than has been usual on steam shovels, and which conduces to economy as well as speed and power.

The shovel is mounted on two all-steel trucks of diamond pattern specially designed for the purpose and having a large excess of strength over the requirements. The axles are of best hammered iron with M. C. B. standard journal boxes. The bolster is formed of a steel box girder composed of two 9-in. I-beams with steel plate top and bottom. The main arch bars are 6 ins. wide. The rear truck is fitted with hand brakes.

The shovel illustrated is working on the New York Central & Hudson River Railroad and frequently loads 10 cars (100 cu. yds.) in 8 minutes. Another is at work on the site for the new terminal for the Pennsylvania Railroad in New York City. One of these shovels is exhibited by the American Locomotive Company at St. Louis.

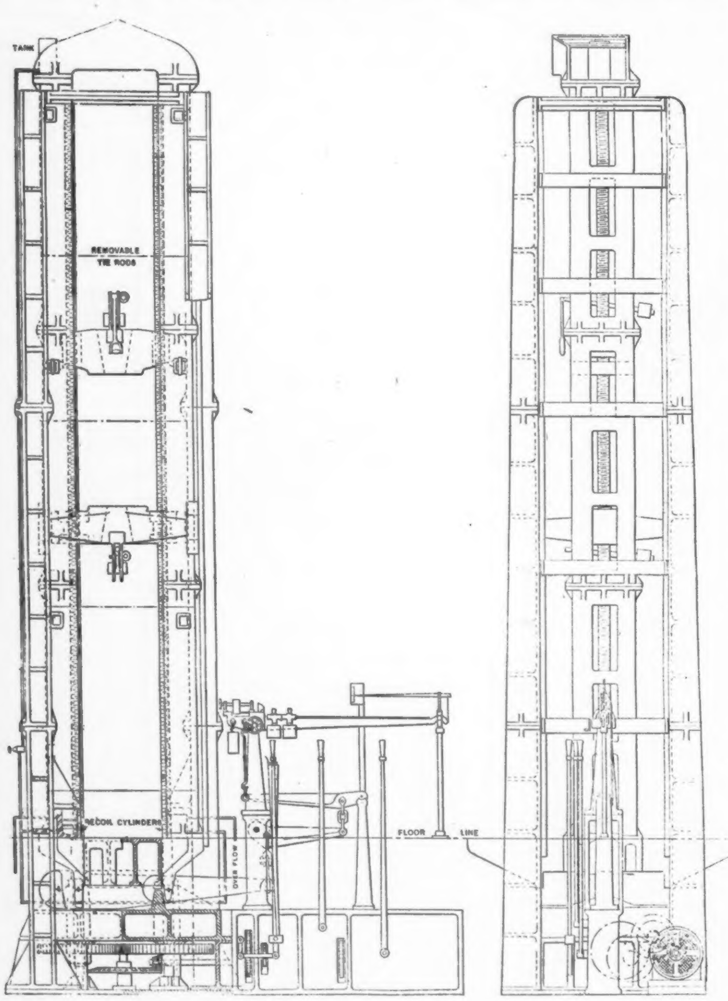
INSTRUCTION CAR FOR MOTORMEN.—Because the new subway in New York is to go into service "full blast" at the opening, trainmen and motormen are being trained to their work by aid of an instruction car equipped with the controlling apparatus for power and brakes and facilities for explaining them fully. About 3,000 men will be needed and only those experienced on steam or electric roads are considered. The rates of pay are to be as follows: Experienced motormen, $3 for a day of 10 hours; first year motormen, $2.75; second year motormen (and after), $3. First year conductors, $2.10; second year, $2.25; third year and after, $2.40. Guards, first year, $1.70; second year, $1.80; after second year, $1.95.

RIEHLE 600,000-POUND TESTING MACHINE.

UNIVERSITY OF ILLINOIS.

The State of Illinois has established at the State University at Champaign, an engineering experiment station for the purpose of carrying on engineering investigations along lines somewhat similar to those followed by the various State agricultural experiment stations. This station has recently ordered from Riehle Brothers Testing Machine Company, of Philadelphia, a 600,000-lb. testing machine of the vertical screw type. This machine is intended for general testing purposes. It is made to take columns, long test pieces, beams, and large irregular shapes, reinforced concrete, stone, and brick construction, built-up metal trusses, and a great variety of test pieces. This is the largest vertical screw-testing machine ever built.

In its general features the machine is similar to the Riehle United States standard vertical screw power-testing machine, with a new feature in the form of four columns to guide the



RIEHLE 600,000-POUND TESTING MACHINE.—UNIVERSITY OF ILLINOIS.

pulling head, these columns being firmly secured to the base of the machine, and entirely independent of the weighing mechanism. The machine has two heads, the upper one being supported by cast iron columns, which rest on and are bolted to the weighing table. A tie piece at the extreme top of these columns holds them together at this end. The lower or "pulling" head is driven by two main screws and moves up or down on the screws when they are turned. The top head may be secured at different elevations according to length of specimen to be tested, and is held in place by two keys which pass through slots in the cast iron columns. The parts which transmit the stress from the specimen to the weighing levers rest on the weighing table and are not connected in any way with the parts of the machine which supply the power. The weighing table is supported on eight hardened steel knife edges in the main levers, and they in turn rest on the steels which are fitted in cast iron bearings on the cover plate. The cover plate is supported by two legs on a steel bed plate, which, in turn, rests upon a concrete foundation.

The beam of the machine is the Riehle dial screw beam graduated in 10,000-lb. marks and reading to 100 lbs. The two poises are driven by a coarse pitch screw, and the nut takes up wear automatically. One poise can be run out at a time. When it reaches the end of the beam it will release itself and the second poise may be thrown in, or, if desired, both poises can be run out together and the reading on the beam doubled. A needle beam with pointer swinging over a graduated dial is used to magnify the swing of the weighing beam, thus increasing the sensitiveness of the machine.

The pulling head has four projecting arms carrying at their ends flat bearing surfaces, bearing against the faces of four guide columns, which are firmly fastened to the bed plate, legs and cover plate, and extend to the highest point reached by the pulling head in its travel. These guide columns are securely tied together at suitable intervals, and take care of any side thrust coming on the pulling head, such, for example, as occurs when long specimens are compressed. The screws are driven by a train of gears and are made of a special grade of steel and have long guides in the cover plate and on the bed plate. All gears are spur gears, except one pair of bevels, and all gears are cut. By means of friction clutches and positive clutches the pulling head can be driven either up or down.

The machine is driven by a 15-h.p., two-phase, 220-volt induction motor, capable of pulling the machine up to full load at speeds not greater than 1 in. per minute, and up to half load at 2 ins. per minute. It is geared to the machine through one direct and one reversing train of gears, and the starting, stopping and reversing are accomplished by a double friction clutch.

Compression specimens are crushed between two cast iron "tools" with hardened steel plates placed on their faces. These tools could be made with spherical seats if desired. Three transverse tools are provided, one on the pulling head and two on the table. The two on the table have cylindrical bases on which they can rock freely. The table has 16 2-in. tapped holes conveniently placed for inserting bolts to hold specimens or tools. Wedge-shaped openings are made in both the weighing and pulling heads on which hardened steel wedges or "grips" slide. These grips are hung on counterbalanced levers with handles by means of which they can be made to "take hold" of tensile specimens, and as stress is applied the holding power increases. The surface of all grips is roughened by cross cuts. Several sets of grips and several sizes of liners are supplied, so that any specimen within the range of sizes given later can be effectively held. The weighing head may be placed in any one of three positions, as may be required by the length of tensile specimen. In each of these positions it is held by two keys passing through slots in the cast iron columns. The weighing head is moved from one position to another by moving the pulling head till the former is lifted so as to loosen its keys; then, the keys being removed, the pulling head and weighing head together are moved to the desired position; the keys are inserted and pulling head moved down.

In place of the rubber buffer used on smaller sizes of machines, the blow on the knife edges due to recoil when the specimen breaks is minimized by causing the energy of recoil to be partially dissipated in forcing water through a very small aperture. The engraving shows the general arrangement of hydraulic cylinders, piping and needle valve used. The machine and motor are to be placed on a heavy concrete foundation. The principal dimensions are as follows:

Extreme height	36 feet 8 inches
Extreme length, including motor	17 feet
Extreme width	10 feet 8 inches
Height above floor	30 feet 8 inches
Weight	100,000 pounds

The machine will take compression specimens 25 ft. long and less; tensile specimens 22 ft. long, with 20 per cent. elongation in 20 ft. and more for shorter lengths; transverse specimens 10 ft. long by 3 ft. wide and less; tensile tools—grips and liners—to take specimens 6 ins. round or square and less to ¾-

in. round or square; 12-in. by 4-in. flats and less; compression tools 20 ins. square and hardened steel plates 6 ins. square, and transverse tools, 3 ft. wide by 18 ins. high. The speeds of machine at 300 rev. per min. of the driving shaft are:

	Inches per minute.
Speed for setting head	8
Quick speed for testing	2
Fast speed for testing	1
Medium speed for testing	0.4
Slow speed for testing	0.1
Slow speed for crushing test	0.05

Fifteen horse-power will be required to operate this machine, using as a maximum speed 1 in. per minute to full capacity of machine, and 2 ins. per minute to one-half the capacity of the machine.

COMMONWEALTH STEEL COMPANY.—Mr. Harry M. Pflager has resigned his position with the American Steel Foundries to accept a position with the Commonwealth Steel Company, of which company he was elected vice-president at the meeting of directors on August 22. Mr. Pflager was for many years mechanical superintendent of the Pullman Company at Chicago. He will direct his attention to the sales department and have his headquarters at the Commonwealth Steel Company offices, in the Bank of Commerce Building, St. Louis.

Mr. F. V. Henshaw, who has for a number of years been active in the management of the engineering department of the Crocker-Wheeler Company, has resigned from that company, and has planned to take a well-earned rest before taking up new work. In addition to a large part of the management of the engineering department, Mr. Henshaw has had entire charge of the estimating and installation work of the above company, and has devoted much study to the broad subject of engineering economies in industrial plants.

BOOKS AND PAMPHLETS.

Types and Details of Bridge Construction. Part I, Arch Spans. Examples of constructed wooden, combination, wrought iron and steel arches for highway and railroad bridges. By Frank W. Skinner, M. Am. Soc. C. E., Associate Editor of *The Engineering Record*. McGraw Publishing Company, 114 Liberty street, New York.

A collection of essential features of special and important work, illustrating variety of design, development of standard practice and methods of erection. It is the purpose of the book to present the development of advanced practice and its standard details, to illustrate the classes of structures adapted to different conditions, show some of the characteristic differences between American and foreign design and illustrate some primitive or obsolete constructions, besides recording important and well known examples, so as to have their principal data easily accessible. The book is divided into four sections: on wood and arch spans, spandrel braced arches, arch trusses, and plate girder arches, and contains 290 pages, is profusely illustrated and arranged and cross-indexed for convenient use.

Boiler Construction. A practical explanation of the best modern methods of boiler construction, from the laying out of the sheets to the completed boiler. By Frank B. Kleinhans. First edition, 1904. Derry-Collard Co., 256 Broadway, New York. Price, $3.00.

As the locomotive type has much in common with the various types of boilers and represents the general class better than any other, and as anyone capable of handling the complicated flanged sheets of a modern locomotive boiler can easily handle the sheets used in other types, the author has deemed it advisable to use it as an example of steam boilers. The construction of the boiler and the various tools used in connection with it are very completely considered in the order in which it goes through the shop, beginning with the laying out of the sheets and following through the various operations until it is placed on the frames, the various fittings, etc., attached and tested, lagged and ready to leave the shop. A section is also devoted to the description, care and repair of boiler shop machines. There are also a number of tables which are useful in connection with boiler construction. It has 421 pages, 334 illustrations and five large plate engravings.

The Coals of Illinois; Their Composition and Analysis. By S. W. Parr, Professor of Applied Chemistry, University of Illinois. 44 pages. Price, 25 cents.

This is No. 7 of the "University Studies," and is by far the most comprehensive work so far undertaken on Illinois coals. One hundred and fifty samples fairly representative of the coal producing area have been studied and the results conveniently arranged in a table for reference. The samples were collected between January and June, 1904, were subjected to the same processes carried on by the same persons; the results, therefore, are more uniform and comparable than any heretofore available. Another striking feature is the introduction here for the first time of a new factor in the proximate analysis of coal, that of "water of composition" as part of the volatile constituent. It is a little startling to see a non-combustible as part of the volatile matter, equaling and often surpassing in amount the sum of the ash and moisture.

Special development has been made also of processes for determining the total carbon, sulphur and coke. Altogether the work is a valuable contribution to our knowledge of bituminous coals in general and Illinois coals in particular.

ELECTRIC GENERATORS.—Bulletin No. 9 issued by the Jeffrey Manufacturing Company, Columbus, Ohio, gives instructions for the care and operation of their direct current electric generators.

The Becker-Brainerd Milling Machine Company, of Hyde Park, Mass., in a small pamphlet briefly describe and nicely illustrate the machine tools in their exhibit at the St. Louis Exposition.

RENOLD CHAIN.—A small booklet, No. 39, issued by the Link-Belt Engineering Company of Philadelphia, describes the construction and operation of this chain and shows a number of applications to machine tools, etc.

SHAPERS.—Gould & Eberhardt, in a new catalog B very completely describe and illustrate the various shapers and attachments made by them, and present several examples showing the practical utility of their shapers for handling odd and irregular shaped work.

BRILL SEMI-CONVERTIBLE CAR.—In this pamphlet, issued by the J. G. Brill Company of Philadelphia, Pa., the various semi-convertible systems are compared and the operation and details of the Brill type are very completely described.

COLD SAW CUTTING OFF MACHINES.—The Newton Machine Tool Works of Philadelphia, Pa. in catalog No. 39, describe and illustrate the various types of these saws made by them. Several interesting motor applications are shown.

TOOLS AND SUPPLIES.—Catalog No. 105, issued by the Chandler & Farquhar Company, Boston, Mass., shows the various tools and supplies handled by them for machinists, blacksmiths, amateurs and all kinds of metal workers.

OLDSMOBILE RAILROAD INSPECTION CAR.—These cars, which are driven by gasoline engines and are designed for use on both steam and electric roads, are very completely described in catalogue No. 112, issued by the Railway Appliances Company, Old Colony Building, Chicago.

ELECTRIC HEATERS.—The Consolidated Car Heating Company have issued catalogue No. 8, which describes the various types of electric heaters made by them for use in cars, and presents some interesting information on the cost of electric heating. These heaters can also be used for house or office heating.

ECONOMIZERS.—The B. F. Sturtevant Company, Hyde Park, Mass. have just issued a new catalog which describes in detail the Sturtevant Standard and Pony types of economizers and compares them with other makes. It also treats of the subject of mechanical and natural draft and is of interest to all steam users.

GISHOLT TOOLS.—The Gisholt Machine Tool Company, Madison, Wis., have issued a set of bulletins describing some of their machine tools. With these is a neat binder, so arranged that future bulletins, which will be issued from time to time, can be placed in it and preserved.

ALLFREE-HUBBELL LOCOMOTIVE.—A pamphlet which thoroughly describes and presents the claims for the adoption of this improvement to the ordinary Stephenson valve gear has just been received. This improved system of steam distribution is being tested on several roads with promise of interesting results. Copies of the catalogue can be obtained from the Locomotive Appliance Company. Chemical Building, St. Louis, Mo.

THE SARGENT GAS ENGINE.—The details and operation of this complete expansion gas engine are very attractively described in a pamphlet issued by the Wellman-Seaver-Morgan Company of Cleveland, Ohio. They also announce that they have secured the exclusive right to manufacture and sell this engine.

JEFFREY WATER ELEVATORS—A small pamphlet issued by The Jeffrey Manufacturing Company, Columbus, Ohio, illustrates a number of water elevators of the chain bucket type, for horse, steam or gasoline power. They operate in wells or for irrigation or drainage works and will lift muddy as well as clear water.

GRINDING MACHINES.—The Norton Grinding Company, Worcester, Mass. have just sent out a catalog which describes their various grinding machines. One of these is a 18 in. and 30 by 96-in. gap machine designed especially for locomotive work. A number of interesting illustrations are given showing samples of work done on these machines with the time required for finishing them.

INSPIRATORS.—In a small pamphlet the Hancock Inspirator Company, 87 Liberty street, New York, call attention to inspirator type E, which in their latest production. In addition to the description of the inspirator it contains an interesting diagram showing maximum and minimum capacities of feed water with different size nozzles and tubes.

CONCRETE CONSTRUCTION.—The Engineering Company of America, with offices at 74 Broadway, New York, have just issued an attractive booklet on this subject. It explains what concrete is, mentions its various uses, treats on concrete reinforced with steel, and calls special attention to its superiority as a fire-resisting material and as a protection to steel against corrosion.

The American Locomotive Company has just issued a 44-page pamphlet describing its exhibit at the St. Louis Exposition. This exhibit consists of twelve locomotives, which represent the present tendencies of American design, and which include two pioneer engines, one the four-cylinder balanced-compound, built for the New York Central, and the other the four-cylinder articulated-compound, built for the Baltimore & Ohio.

BALANCED VALVES.—The American Balanced Valve Company have just issued two very interesting booklets, one on the Jack Wilson balanced high-pressure valve with double admission and double exhaust and the other on the American semi-plug piston valve which is perfectly balanced. The latter describes an extensive test of one of the piston valves extending over a period of thirty-four months. The locomotive in that time ran 91,341 miles and the valves when removed in order to exhibit them at St. Louis were in good condition.

MACHINE TOOL DRIVE.—The Westinghouse Electric & Manufacturing Company, of Pittsburg, have issued an interesting and attractive 42-page booklet on machine tool drives. The relative advantages of the mechanical drive, the group drive and the individual motor drive are considered at length, and the various electrical systems, including the alternating current and the three and four wire direct-current systems are described and compared. The book is profusely illustrated with half-tones showing motor applications to machine tools.

THE BOOK OF THE FOUR POWERS.—This book, which is really a work of art, is handsomely illustrated and is published by the department of publicity of the Allis-Chalmers Company under the direction of Mr. Arthur Warren. The four powers are steam, gas, water and electricity and these briefly outline in a characteristic way the scope of the Allis-Chalmers manufactures. This company has six large plants employing 10,000 men and more than 23,000 large freight cars were required to transport last year's output.

SOFT WATER.—This is the title of an interesting and handsome pamphlet issued by the Kennicott Water Softener Company, Railway Exchange, Chicago, which contains a paper on "Water Softening on the Union Pacific Railroad," by A. K. Shurtleff, assistant engineer of that road. The Union Pacific Railroad has 36 Kennicott water softeners in operation with a total treating capacity of 3,000,000 gallons per day. The paper considers the beneficial results caused by the use of soft water and gives some interesting figures on the cost of treating the water at the various installations.

TRANSPARENT LOCOMOTIVE CHART.—The locomotive transparency with all the parts named which was issued by *Railway and Locomotive Engineering* a number of years ago, will be remembered by all those who were fortunate enough to secure copies. This unique and valuable work has been brought up to date in a new and equally excellent drawing of the same character, illustrating a modern Atlantic type locomotive with piston valves. Every important part is numbered in the drawing and a list of the names appears in the margin. Copies may be had by addressing the Angus Sinclair Company, 174 Broadway, New York; price, 25 cents.

NOTES.

The Walter A. Zelnicker Company of St. Louis have a novel paper weight which they will send to those applying on receipt of nineteen cents to cover postage.

The Continuous Rail Joint Company of America, with offices at Newark, N. J., has many novel features in their exhibit at the St. Louis Exposition that are of interest to railroad men.

The Wellman-Seaver-Morgan Company of Cleveland, Ohio will furnish the Wellman-Street cast steel bolster for 800 Norfolk & Western cars. Two hundred of these cars will be 50-ton hoppers with steel underframes to be built at the Roanoke shops, and 600 will be 40-ton box cars with steel underframes to be built by the American Car & Foundry Company at Huntington, W. Va.

At a meeting of the Board of Directors of the Bullock Electric Manufacturing Company, held on July 30, Mr. W. H. Whiteside, general manager of sales of the Allis-Chalmers Company, was appointed general manager of sales of the Bullock Electric Manufacturing Company, and will have entire charge of the sales department of both the Allis-Chalmers and Bullock organizations.

The B. F. Sturtevant Company, Hyde Park, Mass., have just received an order from Joseph Bancroft & Sons Company of Rockford, Del., for two Sturtevant Standard economizers provided with insulated metallic casing for fronts. The Sturtevant Company is just fitting up an emergency hospital for its employes. It will be thoroughly equipped and will be in charge of a medical student and nurse and a local doctor will attend to all surgical cases.

The Allis-Chalmers Company announces that Mr. Roscoe Cornell has been appointed manager of their branch office which has just been opened up at El Paso, Texas. Mr. Cornell, who had formerly been with the Mine & Smelter Company of Denver, is a graduate of the Michigan College of Mines and is well known as a mining and mechanical engineer. Mr. James W. Lyons has resigned as manager of the power department in order to accept a position as consulting engineer of the Elgin Watch Company and to engage in other consulting work with headquarters at Chicago.

Commonwealth Steel Company.—The controlling interest in this company has been acquired by Mr. Clarence Howard, in which he represents a syndicate. The company is capitalized at $1,000,000 and has a monthly capacity of 3,000 tons of open-hearth cast steel. Under the new management the plant will be devoted chiefly to castings used in railroad equipment. Mr. Howard has been elected president of the company.

Locomotive Appliance Company.—The annual meeting of the stockholders of this company, held in St. Louis August 11, resulted in the election of the following directors: Messrs. W. J. McBride, J. J. McCarthy, F. W. Furry, E. B. Lathrop, J. B. Allfree, C. H. Howard, C. A. Thompson, W. C. Squire, I. C. Hubbell, B. F. Hobart and Dr. G. W. Cale, Jr. This company now has the Allfree-Hubbell locomotive in successful operation on six prominent railroads and the records are reported to be satisfactory in speed, hauling capacity and economy of fuel and repairs.